I.I.H.R. Bangalore Centre:-

The centre is entrusted to work on Solanum Viarum Periwinkle, Rose geranium and Patchouli crops. The centre has also initiated studies on Jasminium grandi-florum exploration and domestication studies. It has developed a culture in Solanum viarrium (IIHH 24-II) under release for high density planting.

Extension Work:

Extension booklet and Phamphlets, on cultivation practices on Opium Poppy Palmarosa. Lemagran, Vetiver have been brought out . The centres have participated in Kisan Melas. Seed and planting material are also being distributed to farmers and enterprenure from all the centres . The scientists in co-ordination unit and at the Project station have given T.V. and Radio talks on cultivation and primary processing of these crops important out extention articles in popular Agriculture Journals during the year.

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

SOME OF THE NEXT STEPS IN BOTANICAL SCIENCE[1]

WHEN one who has worked long in any field of science speaks before an audience such as this he is expected to say something about the condition of his branch of science when he began work with meager and poorly adapted apparatus, to contrast it with its greatly improved condition to-day, and to dwell with pride upon the finely equipped laboratories with costly apparatus especially designed for particular experiments, to be found by the twentieth century scientific student. And I must confess that the temptation to do so was one difficult to resist, for we who have grown old in years are fain to dwell upon the days of long ago with the garrulity which comes with gray heads and withering muscles. It has seemed to me wiser, however, that this evening we should look into the future rather than into the past, for in that direction lies the possibility of progress, and it is of progress that I wish to speak.

THE BOTANY OF YESTERDAY

Yet in order that we may properly orient ourselves with reference to the area covered by the science of botany to-day, we shall have to go back a few decades to understand what additions have been made to its territory during this period of expansion. For the shrewd observer can not avoid the conclusion that botany has shared with the world powers in a territorial growth which has extended its boundaries far beyond those known to the fathers, and

[1] Address of the president of the American Association for the Advancement of Science, Cleveland, December, 1912.

we have annexed much contiguous and even some remote territory in a most imperialistic fashion. It may be comforting to some people to know that during all this time there have been those who have constantly and consistently lifted up their voices in protest against this contravention of the practise of the fathers, and the breaking down and removal of the ancient landmarks. In all these years there have been botanical anti-expansionists, but like their brothers in the national field they have been overwhelmed, and the tide of expansion has swept on unchecked.

Consider for a few minutes the botany of forty years ago, when you could count on the fingers of one hand the American colleges that had chairs of botany. And here I use the term chair advisedly, for they were literally chairs and not departments, much less laboratories. And everywhere else in the colleges of the country the chairs of botany were represented by what Holmes so aptly called "settees" from the number of subjects taught therefrom. The botany dispensed from these chairs was the delightful study of the external morphology of the higher plants, especial emphasis being laid upon the structure of flowers and fruits. And it may truly be said here that often the teaching was done very well, far better than many a botanist to-day is wont to imagine. I am pretty sure that in general the teaching was as successfully done then as it is now. There were some poor teachers then as there are now, and there were some inspiring teachers then who touched their pupils with the sacred fire, as there are now some who have had a divine call to teach and inspire and help.

And with this external morphology there was always associated the classification of the higher plants, in its simpler form the pleasurable pastime of identifying the plants of the neighborhood, and in its more advanced form represented by the work of Torrey and Gray and Vasey and Engelmann. And we should judge the systematic botany of that day by the work of these masters and not by the diversions of its amateurs; and you will agree with me that so judged the systematic botany of that period will not fall short of any standard we have set up in these later days.

The botany of that day was not without its laborious investigations and its tangible results. Every new area was a great out-of-doors laboratory to be diligently studied from border to border. That was the day of the founding of many small botanical gardens, and small local herbaria, some of which having served their purpose disappeared long since, while others have grown into the great and flourishing institutions of to-day.

This much as to the botany of the immediate past; the phase of the science in which the older living botanists were trained.

PRESENT-DAY BOTANY

And what of the botany of to-day? Let us consider for a little the present condition of the science.

It is Unorganized.—The personnel of botany has greatly increased with the great increase in the territory it now includes. This personnel, it must be said, is still quite heterogeneous. Some of us are largely self-taught, so far as the major part of the subject is concerned. We brought to our work the results of the meager teaching of the old-time college class-rooms, and year by year we have enlarged the borders of our own departments as we have added to our own knowledge of the subject by means of our laboratories and libraries. Thus we have built all kinds of superstructures upon the foundations supplied by our teachers. As a consequence the science is yet largely unorganized and lacks consistency in plan and

purpose. Here and there a dominant man has wrought out a scheme of the science for himself, but how familiar is the fact to all of us that there is yet no agreement even upon so small a question as to the content of the first year of college botany, or the mode of its presentation. There is moreover a vagueness as to the boundaries of the science, some botanical teachers wandering far across the border into the domain of some contiguous science, or still more commonly into the more or less practical applications of some portions of botany. This latter indiscretion is especially noticeable in the textbooks prepared for the secondary schools, in some instances by botanists of good standing. If this were done by the agriculturists, the agronomists, the horticulturists, the foresters and others in similar lines of work with plants, it would not be surprising, but when this is done by botanists it is significant of the unorganized condition of the science. With a fuller knowledge of the science there must come a clearer vision of what it is, and what it is not, and we shall no longer find textbooks of botany made to include so much that is not botany, while leaving out so much that is botany.

This difference of opinion as to what constitutes botany results in the absence of united effort. In its simplest aspect it takes the familiar form of uncertainty as to the content and value of the work done by the student elsewhere when he transfers himself from one college to another. As a matter of fact there is yet no agreement as to what is a standard first-year's course in college botany. What teacher has not been sorely puzzled to know to what courses to admit men who came from another college with credits in botany! It is quite unscientific to try to account for this condition by an excusatory reference to the individual peculiarities and the personal differences of the teachers. In science we consider the personal equation as something to be determined and eliminated, and not to be excused and tolerated. Every difference in the treatment of, say the first-year course, is just so far an indication of a more or less unscientific attitude by one or all of the teachers concerned. We work in this haphazard, disconnected way either because we do not know any better, or knowing better we think it not worth while. Either horn of this dilemma is equally unworthy of our acceptance. Ignorance is no valid excuse for the scientific man, and in science everything is worth while. It is to our shame as botanists that we acknowledge our inability hitherto to frame a standard first-year course in college botany. When the science is definitely formulated in the minds of botanists the present disagreement will no longer exist. Surely we now "see as through a glass darkly."

The Applications of Botany.—Again, it may be remarked that we are to-day placing great emphasis upon the applications of botany to some of the great human activities, especially to agriculture. Witness the agricultural experiment stations with their botanists of all kinds, from those who study weeds and poisonous plants, to the physiologists, pathologists, ecologists and plant breeders. And as we look over the work they do we are filled with admiration and pride that they have individually done so well. But it is not the cumulative work of an army of science, it is rather the disconnected, unrelated work of so many individuals. They are doing scientific work in an unscientific way. There is as yet no movement of a united army of science; it has been rather a sort of guerrilla warfare against the common enemy. We lack organization, and like unorganized soldiers we make little headway in spite of

individual learning and efficiency. Botanical science which should have guided and directed these laudable applications has not kept pace with them, and we have the spectacle of these economic botanists, physiologists, pathologists, plant breeders and others working apart from the botanists proper, and sometimes even disclaiming any allegiance to the parent science. Nothing but confusion and disaster can result from such a condition.

Lack of Cooperation.—Contrary to what is sometimes affirmed, botanists are still studying the flora of the country. In some quarters there has been expressed the fear that field botany has disappeared from the schools and colleges; but this is far from true. While it no longer claims the larger part of the student's attention, it is still an essential part of the training of every botanist, and it is probably true that in some cases there is even more field work required to-day of young botanists than its importance demands. Certainly in one kind of field work I should like to see some of the energy and ability now given to the discovery of means for splitting old species turned towards the solution of problems pertaining to growth, and development, and reproduction. But the careful field study of what plants grow here and there, and why they do so, is greatly to be commended. The sociology of plants, or as we call it, ecology, has given in the last few years a new reason, as well as a new direction to field botany.

The systematic botany of to-day continues to concern itself more with the distinction of species than with their origin, and this has brought to this department of the science an increased narrowness which has greatly injured its usefulness. On the other hand plant breeding, which should be the experimental phase of systematic botany, has had no connection with it. And strangely, systematic botany, which should welcome plant breeding as an ally in its quest as to the meaning and origin of species, has been scarcely at all interested. It has been left to the florists, the horticulturists and the agronomists to patronize the new phase of botany, and this they have done, in spite of the new and quite unnecessarily formidable terminology so rapidly developed by the breeders. So what might have proved to be one of the most helpful aids to the solution of the greatest of biological problems—how living things have come to be what they are—is allowed to fret out its life by beating vainly against the technical bars of its Mendelian cage. I know of no better illustration of the unorganized condition of botanical science than this failure of the systematic botanists and the plant breeders to work together for a common end.

THE BOTANY OF TO-MORROW

But I have dwelt enough upon the past and the present, and I feel inclined to apologize to you for having turned your faces so long backward. For while we must consider what has been, we can make progress only by planning for what is to be. So let us turn now to the future of botanical science, and endeavor to trace its more profitable course of development during the next one or two decades. What are seemingly to be the demands of modern society upon this science? What are to be some of the next steps in its evolution? For whatever we may say in regard to the independence of science we can not escape the fact that it must serve its "day and generation." No science can hope for support or recognition that does not respond to the demands of its age. And yet we must not ignore the labors of those pioneers in every science who foresee possibilities that are hidden from the mass of men.

There must always be place provided for the few seers who see to-day what is now hidden from mankind in general, and may continue to be so hidden for generations, or centuries. All honor to these prophets who prepare the way for the oncoming of scientific truth, but it is true, nevertheless, that it is only when such truth has permeated contemporary society that science thrives.

Its Content.—Looking forward, then, let us try to see the trend of that branch of science which deals with plants, the science which I have the honor of representing on this platform this evening. And my first inquiry may well concern itself with the content of botanical science in the immediate future. As we become better acquainted with it and recognize more clearly its relations to the activities of the community we shall be able to define its proper content with more accuracy. And let no man attempt to belittle the importance of such an undertaking. It is not useless to attempt to fix the boundaries of any field of human endeavor, especially in such a one as this which deals with so vast a number of individual objects, each having many possible relations to one another and to ourselves. I am well aware of the impossibility of absolutely delimiting botany from every other science, and especially of doing so with reference to many of its applications, and I am fuly aware of the fact that the limits of any science are subject to change with the progress of human knowledge. Now and then there must be a "rectification of the frontier" in respect to the boundaries of a science, as with the boundaries of a great empire, as its farther provinces and the exact location of rivers and mountain ranges become better known. So without doubt we shall have to add to or subtract from the area now allotted to botany; and yet I feel that it is worth our while to spend a little time in indicating its present boundaries and content.

With all the details that may be insisted upon by some specialists it still is true that the field of botany may be considered in three parts, structure, physiology and taxonomy. Beginning with such structures as are obvious to our unaided eyes we have carried our studies to the minute structure of the tissues, and the cells which compose them. We are able now to peer into the protoplasmic recesses of the living cell, and while we can not say that we have seen life, we have seen where life is, and what it does. Cytology, histology and morphology in our modern laboratories have greatly changed our conception of the structure of the plant. It is no longer made up of forms to be compared because of their general similarity of outline, or of position in the plant body. The plant as a whole is a community of variously differentiated living units, just as is each of its organs. It is a complex community in which there is a measure of individual independence of the units, along with much of mutual dependence.

This leads me easily to that portion of the field of botany that has to do with the activities of plants and their organs—physiology—whose scope has been so greatly extended in these later years. Here such inquiries as those pertaining to nutrition, growth, sensibility, reproduction are of primary importance. The introduction of the experimental method of inquiry has made this a favorite department of the science. Who does not enjoy catching a plant, tying it up in a corner and compelling it to do something, while we watch for the result? This kind of study appeals especially to those who are looking for demonstrations, and for this reason plant physiology has been increasingly popular. Some botanists indeed have gone so far as to insist upon

giving first place to physiology, probably because of its ready appeal to our senses. It is easy to interest a boy in the thing that responds, whether it be a kicking frog stimulated by an electrical discharge, or a green plant whose stimulation is a properly directed beam of sunlight. And yet it is well for us to remember that the plant is first of all a structure, whose complexity may well challenge the most acute minds. We find it far easier to record the responses of plants to our planned stimuli than to unravel a structural complex, and so no doubt we shall continue to entertain ourselves and our students with what are too often futile experiments.

In this part of the botanical field are pathology, which grew up from our observation that organs may not respond normally; ecology, which developed from the observation that plants tend to live in communities; and phytogeography, having to do with the means for and the results of distribution. There are signs that for economic reasons pathology may become rather sharply set off from physiology, of which it is properly a part, much as through the zeal and enthusiasm of the ecologists there was once the suggestion of a physiological schism. The latter is happily no longer imminent, and it may be hoped that it will not again threaten the unity of plant physiology. And so it may be hoped that the pathologists will not wholly secede from association with the physiologists.

Taxonomy, or as we used to call it, classification, occupying the third division of the field of botany, long received the almost exclusive attention of botanists. And even to-day it is the pretty general opinion of our non-botanical friends that we are constantly employed in collecting specimens, and in some intricate and mysterious way determining their classification and affixing to them their proper Latin names. And it must be admitted that every botanist does a good deal of just such work, quite as every chemist makes many analyses, and tries to arrange in orderly sequence the chemical substances which he has in his cabinet, and the astronomer classifies and names the heavenly bodies with which his science deals. At first even the botanists knew but few plants, just as now most men know scarcely more than a score. But as the botanists came to know a larger number of plants, it was imperative that they should be named, and then grouped conveniently for easier reference. Thus arose such crude, primitive classes as herbs, shrubs and trees, which served their purpose until the numbers became too great again, when additional structural differences were brought in to help separate the large numbers into smaller groups. This was the earlier classification, based upon structure alone. It was taxonomy without doubt, and it was helpful, since it enabled us to arrange plants in an orderly fashion, but it ignored the fact that plants have ancestors, and that the plants of to-day are what they are through their inheritance of ancestral characters, accompanied by modifications peculiar to them alone. When, however, the doctrine of evolution came into botany it brought with it the idea of descent, and thereafter taxonomy included phylogeny. To-day the taxonomist is no longer content to stop with a knowledge of the structural differences between plants; he must know how this structure arose from that; he must know which is the primitive structure and which the derived. Phylogeny has so far entered into taxonomy that it has given new meaning to the work of the systematic botanist, and it is bringing into this department of the science something of the philosophical aspect which was nearly

wanting heretofore. That this must be the direction of the development of the taxonomy of the future is without question, and we may look confidently for a marked expansion and enlargement of the phyletic idea in botanical taxonomy.

And here I may pause for a moment to advert to a part of taxonomy with which some biologists have little patience, without good reason, as it seems to me. I refer to the matter of taxonomic nomenclature which has vexed the souls of many botanists, especially during the past one or two decades. However, since every science must have its nomenclature it is childish for us to wish to ignore it in botany. It is a part of the science, and we must give it consideration if we are to do our full duty. I have been surprised many times when men have spoken disparagingly of the whole matter of nomenclature, and of those who are giving time and effort to its stabilization. While it may be granted that not every botanist is in duty bound to help to settle questions of nomenclature, or even to take part in framing the general rules of procedure, it is the duty of every one to appreciate and encourage those who are so engaged. It has sometimes seemed to me as I have heard wholesale denunciations of nomenclature and nomenclaturists that instead of being botanists we are only cytologists, morphologists, physiologists, pathologists, ecologists.

This contempt for nomenclatural questions is symptomatic of a much-to-be-deprecated state of mind, quite too common among scientific men, especially those who have engaged in special lines of work. I believe in specialization in botany, but specialization should not degenerate into narrow bigotry. A wise man long ago admonished his friends in words which I am tempted to repeat here as most fitting:

> But now they are many members, but one body. And the eye can not say to the hand "I have no need of thee"; or again the head to the feet, "I have no need of you." Nay, much rather, those members of the body which seem to be more feeble are necessary; and those parts of the body, which we think to be less honorable, upon these we bestow more abundant honor, and our uncomely parts have more abundant comeliness; whereas our comely parts have no need: but God tempered the body together, giving more abundant honor to that part which lacked, that there should be no schism in the body, but that the members should have the same care one for another.

Wiser words of counsel for the workers in different parts of the field of a science were never written, and I beseech you, my botanical brethren, to heed them, "that there should be no schism in the body" of botany.

Personality of the Botanist.—Quite easily the foregoing leads to a consideration of the personality of the botanist of the immediate future. What manner of man will he be? What will be his training? In other words, what will the future demand of the botanist? For it does not need argument to show that the men engaged in botanical work in the future will be developed and fashioned in response to the demands of the community.

If I interpret aright the movement of modern society as a whole, it is going to result in a demand for two things that by many are thought to be opposite and antagonistic—specialization and breadth. The first it will demand of its experts, the men who are set aside to solve particular problems for the community. In most cases these will be economic problems of immediate importance to the community, but there is no reason why in the most intelligent communities they should not be scientific problems, of more remote importance. No doubt there will be a demand for many such experts, each of whose tasks will be

restricted to but one problem. The only requirement laid upon these men will be that they can do the work to which they have been assigned, and the more restricted the problem the narrower may be the preparation of the expert. Such men will be demanded in increasing numbers by the scientific bureaus of the general government, by the state experiment stations and by large private establishments engaged in beet growing, cane growing, fruit growing, potato growing, hop growing, etc., and it will be the duty of the teachers of botany to produce an adequate supply of such botanical experts.

But while the community is certain to increase its demand for botanical experts we must not overlook the fact that with this demand will come another, much more imperative, for men of far greater breadth and depth of knowledge, who in addition to training the botanical experts of various kinds for the community, are able to bring the science as a whole before the youth of the land as a part of the scientific culture which modern society requires. These must be men of the broadest training; men whose sympathies are not bounded by the one science which they know, much less by one phase of botanical science; men who, knowing well their one science, know also much of the related sciences; men who in addition to a knowledge of science bring to their students and their community the results of that broader view which relates botany to the life and activities of the community. Such men bear the name of botanists worthily, and justify the contention of scientific men that science may contribute more than material good to the community. These are Lord Bacon's "Lamps," and "Interpreters of Nature."

And my vision is by no means unrealizable. Already among botanists there are those who measure up to this ideal. Already there are those who to a wide and deep knowledge of plants add that breadth of culture that brings them into sympathetic relations with the company of scholars throughout the world. As I speak these words there will come to you the names of those of our number who are known and honored as botanists, but whose beneficent influence extends far beyond the limits of their science. And I am confident that this high standard, now reached by some, will be demanded for all by the community of the future. Such botanists will be the leaders of their students, guiding wisely their early steps in science; they will be the leaders of the experts whose results they will be able to relate to other parts of the botanical field; and they will be the leaders of the community, not only in the applications of botany to the solution of material problems, but in a larger and nobler manner they will be able to help them in the higher things that make for culture and spiritual uplift.

The Teaching Institutions.—Turning now to the institutions of learning—the colleges and universities—where botany holds a place as one of the sciences, let us ask what we may look for in regard to its development. In every proper college the department of botany exists primarily for its teaching function, and this is true also for nearly every university. And while we may hope to make every such department a center of investigation also, it is true now, and it must always be true that in our educational institutions the teaching of the science must be the primary object of every one of its scientific departments. So the future will call for much more of definiteness as to the content and sequence of the science, as well as the manner of its presentation; its pedagogics, if you please.

The college and university departments of botany in the near future will arrive at

a clearer notion as to the essentials of the science as a subject of study. It seems to one who carefully looks over the field that there is often only the most vague notion of the relative importance of the known facts in regard to plants, those of trivial importance receiving as much weight, perhaps, as those of profound significance. Especially is this true of the more elementary courses, in which there is also the greatest diversity in the presentation of the subject matter. This condition argues incompleteness of knowledge either as to the science as a whole, or as to its pedagogics. We have all heard the excusatory remark that "it makes little difference how or where we begin the study of plants, and in what sequence we pursue it." Yet none of us would admit such a contention in regard to any other matter. The more we know of a country, the more definite are our ideas as to what are its more important mountains, rivers, cities and institutions, and it is these that we feel the traveler should see. We particularize when we know; we generalize, and are vague, when we do not. It should not be long until this vagueness and doubtfulness as to substance and manner in the presentation of botany in the high school, and in the college, and in the university, will be a thing of the past. In the near future we shall certainly have the lower work clearly defined, as it is in mathematics and language, and on this the higher work will be based, to the great saving of the time and energy of teacher and student, now needlessly wasted. And I appeal to you, botanists, to take up seriously the task of so arranging and coordinating our work that botany shall no longer suffer the reproach of being the most chaotic of the primary sciences. Do not tell me that we can not agree. *We must agree.* If we know our science sufficiently well we can easily discern the more important parts. Let him whose knowledge is too limited to enable him to see over the whole field step aside. Let him who has no adequate perception of the pedagogical aspects of the problem step aside. Then let the select few make a pronouncement, subject to periodical revision. This is the way that scientific men should settle the question. This is the way it will be settled some day, in the not very distant future.

The Botanical Stations.—But the college and university departments are by no means all that are engaged in botanical work. Within the past twenty-five years many stations have arisen in which botanical investigations are made. Under various local names they are in fact "investigation stations" and while their results have not been uniformly reliable it is a most hopeful sign of progress that they exist at all. Foremost among these are the fifty or more agricultural experiment stations to which I have already briefly referred, with assured support from the states and the national government for all time to come, in which botanical investigation forms no inconsiderable part of the work undertaken. Hampered as they generally were in their earlier years by incompetent direction, and often by still more incompetent workers, it is gratifying to know that year by year there has been marked improvement in both, and that now many of the directors are men of such scientific training that they wisely use the means at their disposal for investigations of permanent scientific value. And if I read aright the tendencies in these stations, it will not be long until their scientific output will be wholly reliable, as indeed it is now in some cases. This condition will be fully realized when these stations are wholly under the direction of men of broad scientific training.

And here again we have a duty to perform. We must recognize the agricultural

experiment stations as permanent parts of the botanical equipment of the country. They will be with us in the future, and their results will continue to be added to botanical knowledge. We must accept them as a part of our scientific equipment, and help to make them more efficient. It will not do for us to stand aloof, and decry their results as not accurate, and as agricultural instead of botanical. When we fully realize that we have in these experiment stations so many institutions of endowed research, we shall not hesitate to welcome them to the ranks of science. The fact that these researches in regard to plants so often have an economic purpose does not lessen the value of the results to the botanist of broad training and sympathies. Here again we must remember that as botanists we should not undervalue those contributions to knowledge in which we happen not to have an immediate interest. My scriptural quotation of a few minutes ago might well be repeated here: "the eye can not say to the hand 'I have no need of thee,' or again the head to the feet 'I have no need of you.'" When they receive the hearty cooperation of the botanists of the country the agricultural experiment stations will develop into centers of investigation of the greatest importance to science.

Already we have stations for the study of plants under particular environments, as our seaside stations, our mountain stations and a single desert station. I take it that these are suggestive of what are to come in the future. Instead of trying to make seaside conditions away from the sea, we go to the sea and there set up our laboratories. So when we want to know how plants behave in the desert we go to the desert. And this is no doubt to be the direction of botanical investigation. We are going to study plants under their natural environment, and to the seaside laboratories we shall add (as indeed we have already to a limited extent) lakeside laboratories, riverside laboratories, swamp laboratories, forest laboratories, field laboratories. Already the tropical laboratories, in Java, Ceylon and Jamaica have justified themselves, and no doubt to these we shall soon add arctic and tundra laboratories. All this signifies that more and more we are going to see what the plant is doing in its natural environment, and then we can undertake intelligently to watch it under a changed environment. So the future is to witness a great increase in the number of these laboratories, and how far it will go can only be conjectured. It now appears probable that eventually every botanical department will have one or more of these environmental laboratories in which work may be done by advanced students. They will take the students out of doors, as the old-time systematic botany took them out, but these students will go equipped with thermometers, psychrometers, anemometers and balances, instead of vascula and plant presses. Thus we shall again go afield, but on what a different quest! The old-time botanist in the field was mainly concerned with the question of the specific identity of each plant he found; the botanist afield in the future will ask what the plants are doing under this or that environment. He will not neglect the earlier question, in fact he must have that answered, but that answered he has still his main question before him. The work in the field laboratories must necessarily be of the kind now called ecological, and so as I see it the botany of the future will have much more of ecology than is common to-day.

Yet when we think of these botanical stations whose laboratories are taken afield, as it were, we must not suppose for a moment that the old-time laboratories on the uni-

versity campus are to be abandoned. Far from it. As the work in the field laboratories is enlarged there will be still greater need of the far more exact work that can be done only in laboratories where every factor can be perfectly controlled. There will still be need, greater need I might say, for perfectly constructed plant-houses in which we may observe plants under controlled conditions, and where we may increase or decrease this or that factor at will. I emphasize this point because there are some who prophesy the eventual abandonment of the precision laboratory in botany, when in fact everything points to the opposite conclusion.

Another kind of station, of which we have now only the beginnings, is one which will carry the results of plant breeding into the domain of phylogeny. Of this we have now some faint suggestions, which must grow into far reaching results under the direction of men who know more of the subject than we do now. It may be that such stations will then, as now, have a strong economic bias, but this will not so narrow them as to exclude the phylogenetic aspects of the work they are doing. In such laboratories we shall be able to see how evolution has contributed to the present wonderful diversity of form and size and color and habit among related plants. Such laboratories will enable us to answer the demand formerly so often made, but less often heard now, for a demonstration of cases of actual evolution. Although such cases are well known to botanists, their occurrence has hitherto not been such as to admit of easy citation for purposes of popular demonstration. So I regard the breeding laboratories of the future as welcome additions to the means of demonstration which science will possess.

Unity of Action.—Allow me to look once more into that future which holds so much of promise for botany. I am assured as I consider the trend of scientific thought that there will be greater unity of action among the botanists of the country. At present we are still in the guerrilla stage of botany, in which every man acts independently and for himself. And it must be admitted that much effective work is done by guerrillas in war and in science, but in both there is far too much waste of energy. Let me pause a moment to explain more fully what I mean by this guerrilla condition in botany. Although we profess to be botanists acting for the best interests of science, we have actually no uniform standard by which we may measure our actions. In one particular we have tried to set up a standard, in certain international rules pertaining to nomenclature: and yet after several congresses of botanists we have the humiliating spectacle of a set of laws that nearly everybody disobeys! In other matters also, every man does as he pleases; and the worst of it is that he vehemently defends this free, untrammeled mode of action. We have been guerrillas so long that we resent the suggestion of conformity to any regulation.

Brethren of the ancient order of botanists, this is scientifically quite unseemly. We must cease this personally independent, but disorderly life, and enroll ourselves in the regular army as good soldiers who will obey orders, and who will act in unison for the common good. And this is no illusory vision. It is one of the things that the future will bring us, yes, I may say, is bringing us. For already we find the beginnings of a reduction of some of the disorder in certain fields of work. In the management of the work of the agricultural experiment stations there are hopeful signs of a healthy progress. Certain officers in Washington, having general supervision over the stations, seeing that there is much useless

duplication, have begun suggesting more harmonious planning, one station to emphasize this line of investigation, and another that line, instead of working quite independently of one another. This beginning is suggestive of what might and should be done elsewhere.

And we shall not confine unification and coordination to investigation alone, but will carry it into the teaching departments. As a matter of course the more general aspects of the science must find place in every college department of botany, requiring to this extent the quite legitimate duplication of the best laboratory and other facilities that can be provided. But beyond this the duplication should cease, especially of facilities that are costly in installation and maintenance. When we fully reach a condition of scientific sanity we shall agree upon such a program as will assign particular fields of work to those institutions that are best able to care for them, and it follows that students will be sent to these for such specialties. In the case of the state institutions there is already the beginning of the attempt to reduce needless duplication—in some instances crudely and awkwardly, it is true—but the significant thing is that there is already an attempt to reduce duplication. Which suggests that "the children of this world are in their generation wiser than the children of light."

This is not the place for the discussion of the details of the educational cooperation which is coming—a cooperation which will result in a conservation of educational energy. As the details are needed they will be worked out, but I may be permitted to suggest that in the near future we shall reach a solution something like the following:

(*a*) That the small colleges shall provide a standard course in general botany, with adequate facilities as to material and apparatus.

(*b*) That the larger colleges and universities shall provide an identical standard course for those of its students who have not pursued this subject in the small colleges, and to this they will add certain advanced, also standardized, courses, requiring facilities beyond the reach of the small colleges.

(*c*) Then will come, especially in the state-supported schools, such advanced courses as are required by the nature of the institutions, and the needs of each particular state; as the study of useful plants, noxious plants, local systematic botany, dendrology, pathology, etc.

(*d*) Last will come a division of labor with regard to the more profound lines of research and teaching. Certain favored institutions will place especial emphasis upon minute anatomy (cytology and histology), or special morphology, or physiology, or plant breeding, or ecology, or phytogeography, or special taxonomy, or general and experimental evolution, or botanical history, etc.

These suggestions are not chimerical. They are indicated by the recent trend of scientific thought, which recognizes more and more the value of the conservation of human effort. And as I look into the future a vision rises before me of the scientific army, working harmoniously like well-drilled soldiers, and not wasting their strength by turning their guns on one another. In this army of science I see a company of thoroughly disciplined botanists who in orderly fashion plan their campaign. And, from the many doing severe garrison duty in the small colleges, to the heavy artillerymen in the big university fortifications, and the few isolated scouts along the frontier of special investigation, all are actuated by a common spirit of scientific patriotism and loyalty.

This, my botanical brothers, is what the

future is bringing us—a united, harmonious body of trained men, whose endeavor is to carry forward the banner of science, not for personal advantage, but for the glory of the science to which we have dedicated our lives.

CHARLES E. BESSEY

RECENT EXPLORATIONS IN SIBERIA

ACCORDING to recent information received from the American Consul at Vladivostok (transmitted to the Dept. of State, Sept. 10, 1912), and from other sources the following scientific exploration has been carried on during the current year in the Russian far east:

An important work was carried on in Siberia by the Russian Geological expeditions sent out to look for new gold deposits. The Russian Mining Department had expeditions in the Bargusin district on the Zeia River, in Minusinsk and in Kamchatka. The Russian Mineralogical Society was studying Lake Ingol in the Achinsk district. The Russian Geological Society has also begun an extensive study of the Kalbin Mountains in the Ust-Kamennogorsk district on the left bank of the river Irtish, where three independent parties are working at present. A Russian Gold Mining Company is studying the river Kolba, for which purpose three professors of the Tomsk University have been engaged. The Russian Geological Society has also sent out an expedition to study the country on the river Yenisei from Krasnoyarsk down to Dixon Island, situated in the Arctic Sea about two miles from the mouth of the Yenisei River. The purposes of this expedition are the study of the magnetism of the earth, and the definition of the astronomical coordinates for the northern sea route. An auxiliary motor schooner has been sent to the village Dudinskoe to serve as a temporary magnetic laboratory. The Yenisei River will also be studied from a botanical point of view, and the fish resources of the river are to be investigated.

The director of the Irkutsk Laboratory is making magnetic observations on the Lena River down to its estuary, where the region of the maximum magnetic force is located. The Colonization Department is making studies of the flora and soil in the Semiretchie, Barabinskaia Steppes in Kainsk and Mariynsk districts and in Akmolinsk Province.

The Russian Society for the Study of Asia is investigating the unknown ruins on the right bank of the river Obi in the Barnaul district. Bones of animals and birds, stone and bone weapons and articles of bronze and copper have been found, as well as some fragments of pottery with ornaments belonging to an old civilization.

Dr. A. Hrdlička, of the United States National Museum, has been engaged in anthropological exploration along the upper Yenisei River, on the Selenga, and in northern Mongolia.

The Altai is attracting special interest and several well equipped expeditions are working there on various lines.

Siberia, and especially the Russian Far East, seem to attract a great deal of attention in Europe. The French Department of Education, the Geographical Society and the Museum of Natural and Historical Knowledge have sent Daniel Busson with assistants to Siberia to prepare ethnographical, anthropological and natural history collections, as well as to take photographs and moving pictures. From Irkutsk they are to go to the Transbaikal, and from there to Yakutsk by the Lena River and from the river Kolima to Vladivostok. Much interest is manifested in scientific circles, as well as by students of economics, in regard to this almost unexplored and unexploited country which is so rich in opportunity for the seeker after truth.

Professor George Mixter, of Boston, has recently concluded a successful scientific expedition and hunting trip in the vicinity of Lake Baikal under the auspices of the Smithsonian Institution, Washington.

A Russian expedition has been sent out from St. Petersburg to examine the coasts of the Okhotsk Sea, the valley of the Anadir River close to Behring Straits, and the Gischiti and Aldon valleys. The chief of the expedition is Mr. P. I. Polevoi, a learned geologist and mining engineer, who is accompanied by topographers of the army.

It is further reported that the following expeditions have or will also visit Siberia:

1. An expedition to the Altai Mountains by Professor Lyman and Mr. Hollister for the purpose of making a collection of plants and animals for the United States National Museum and Harvard University.

2. Dr. Stanislav Hanzlik, professor of Prague University, to make a study of climatical and meteorological conditions of the Russian Far East.

3. Sven Johan Ernandero, a Swedish explorer, to make a botanical study of western Siberia.

It should also be remarked that the matter of perfecting the northern route from Vladivostok to European ports via Behring Straits (so successfully navigated last year from Europe as far as the Yenisei River by the English navigator, Captain Webster, and from Vladivostok to Kolima River by a Russian vessel), and the charting of the new uncharted coast lines in many places on this route, is receiving attention from a special Russian expedition which sailed from Vladivostok at the opening of navigation this year. They will winter in the Arctic Sea and proceed next year on their voyage.

A. Hrdlička

THE REORGANIZATION OF THE MEDICAL DEPARTMENT OF THE UNIVERSITY OF CALIFORNIA

At a meeting of the regents of the University of California in December, 1911, the Committee on Medical Instruction recommended that the departments of the Medical School in Berkeley and San Francisco be brought together in San Francisco as soon as possible, that the clinical years be put upon an academic basis, and that a proper teaching hospital and proper laboratories be provided in order to promote the best interests of the university as a whole, and of the Medical School in particular. It was declared the desire of the board to establish a medical school of the highest standard.

At a meeting in April, 1912, upon the recommendation of the Medical Faculty, the following plan of reorganization was adopted. Clinical instruction in the medical school is to be carried on in three main departments. (1) Gynecology and obstetrics: it was decided to put this department upon an academic basis at once and to allot full academic salaries for a professor and an assistant. (2) Medicine: this department to include pediatrics, neurology and dermatology. This department can not as yet be placed upon a full academic basis, but $2,300 has been devoted to the payment of assistants for the current year. (3) Surgery: this department to include orthopedics, urology, ophthalmology, rhinology, otology and laryngology. As with medicine, there were not sufficient funds available this year to put the department upon a full academic basis, but $1,800 was devoted toward paying three assistants.

In addition to the main departments, the work of the hospital pathologist was reorganized and an additional assistant professor of pathology was secured at a salary of $2,400 a year. It was voted to grant $1,200 for the work in radiography.

The budget voted to medicine 1912–13, for maintenance of the first two years, was:

	Salaries	Budgets	Total
Anatomy	$11,500	$3,555	$15,055
Physiology and physiological chemistry	8,120	3,000	11,120
Pathology and bacteriology	9,900	3,800	13,700
Toward academic instruction in the clinical years			12,000
For additional expenses of the clinical years:			
General budget			7,630
Special budget for university hospital			6,430
Assistant superintendent and hospital stenographer			2,400
Deficit			12,000
Total for medical instruction			80,365

In accordance with the plans adopted by the regents, a movement is on foot to provide a new university hospital. The present plans aim at four units of forty to fifty beds each, to be devoted respectively to surgery, medicine, diseases of women and diseases of children. Money has already been given ($350,000) by private individuals to build and equip the departments of medicine and children's diseases. In order to carry on the work in the present buildings, the regents have granted $14,000 for alterations in the hospital for accommodation of clinics, and $6,000 for equipment of clinical and pathological laboratories. A children's ward has been added to the hospital.

SCIENTIFIC NOTES AND NEWS

The following have been elected corresponding members of the Munich Academy of Sciences: Dr. Otto Struve, professor of astron-

omy at Berlin; Dr. Mittag-Loeffler, professor of mathematics at Stockholm; Dr. H. A. Schwarz, professor of mathematics at Berlin; Dr. Walther Nernst, professor of physical chemistry at Berlin; Dr. Sigismond Exner, professor of physiology at Vienna; Professor A. G. Nathorst, director of the Paleontological Museum at Stockholm, and Mr. Bailey Willis, of the U. S. Geological Survey.

DR. H. A. LORENTZ, professor of physics at Leiden, has been made an honorary member, and Dr. Ernest Rutherford, professor of physics at Manchester, and Dr. W. C. Brögger, professor of geology at Christiania, have been made corresponding members, of the Vienna Academy of Sciences.

THE honorary degree of D.C.L. has been conferred on Sir William Osler, regius professor of medicine at Oxford by Durham University.

THE Paris Academy of Sciences has awarded its Binoux prize (for the history of science) to Professor J. L. Heiberg, of the University of Copenhagen, for his works on the history of ancient mathematics and in particular for those on the method of Archimedes.

DIRECTOR BAILEY has been appointed to represent Cornell University at the inauguration of Dr. C. A. Duniway as president of the University of Wyoming on January 24. Besides making a speech at the inauguration, Mr. Bailey will make an address on the occasion of the laying of the corner stone of Wyoming's new agricultural building.

ON the evening of December 17, the Linnean Society of New York held its first annual banquet at which Mr. Frank M. Chapman was the guest of honor. The occasion had the twofold object of inaugurating a series of annual dinners and of honoring Mr. Chapman for his distinguished services to ornithology. Dr. Jonathan Dwight, Jr., president of the society, acted as toastmaster, and among other guests at the speaker's table besides Mr. Chapman were Dr. Henry Fairfield Osborn, Mr. John Burroughs, Dr. A. K. Fisher, Mr. George Bird Grinnell, Mr. T. Gilbert Pearson, Dr. Frederic A. Lucas, Mr. Spencer Trotter, Mr. Ernest T. Seaton and Mr. John H. Sage.

PROFESSOR H. J. WHEELER, for the past ten years director of the Agricultural Experiment Station of the Rhode Island State College, who recently resigned, has accepted the position as manager of the Agricultural Service Bureau of the American Agricultural Chemical Company of Boston and New York, with headquarters at 92 State St., Boston, Mass.

MR. BENJAMIN BOSS has been appointed acting editor of the *Astronomical Journal.*

MR. H. D. GOODALE has recently been appointed by the trustees of the Massachusetts Agricultural College as research biologist in the department of poultry husbandry of the experiment station. Mr. Goodale graduated from Trinity College in 1903; after spending a year in graduate work at that institution, he spent three years at Columbia University as a special student of zoology. From 1907 to 1911 he was engaged in farming, and since 1911 has been employed by the Carnegie Institution of Washington in its department of experimental evolution.

THE cornerstone of the new dispensary building of the College of Medicine of Syracuse University was laid on December 14 by Chancellor Day. Afterwards addresses were made by Dr. William S. Thayer, of the Johns Hopkins University; Mr. Augustus S. Downing, assistant commissioner of education of the state of New York, and Mr. Alan C. Forbes, who spoke on behalf of the Syracuse Free Dispensary Association.

PROFESSOR MARSTON TAYLOR BOGERT, of the department of chemistry, Columbia University, president of the Society of Chemical Industry, lectured on December 16, before the McGill Chemical Society, Montreal, on the subject of "The Classification of Carbon Compounds," and in the evening addressed the Montreal members of the Society of Chemical Industry at a banquet at Coopers Limited. On the following day he addressed the Toronto members of the society at a banquet at the Engineers' Club, Toronto, on the subject of "A Closer Cooperation between the Universities and Chemical Industries."

Dr. E. V. Farwell, associate professor in the department of chemistry of the college of agriculture of the University of Wisconsin, lectured to the students of the department of chemistry, on December 18, on "The Rôle of Mineral Elements in Nutrition."

Dr. E. P. Lyon, of St. Louis University School of Medicine, recently delivered the Founders Day address at the Bradley Polytechnic Institute, Peoria, Ill., on the subject, "Medicine and Engineering."

Mr. Austen Chamberlain will preside at a meeting at the Royal Colonial Institute, London, on January 14, in support of the fund he is raising for the extension and development of the London School of Tropical Medicine, when Sir Ronald Ross will give an address on the work of the school and the advantages of tropical medicine.

Certain geological works of Dr. Alexander Winchell, former professor of geology at the University of Michigan, have recently been found at the state capitol at Lansing, where they have been kept since Dr. Winchell's death forty years ago. Over four hundred works are included in the collection, which is a very valuable one, including plates and hand drawings. The works are the property of the Michigan State Geological and Biological Survey, and will be published in an appropriate form.

The valuable collection of microscopic slides and preparations left by the late Professor T. H. Montgomery, Jr., have been given by Mrs. Montgomery to the zoological department of the University of Pennsylvania. The collection comprises upward of 3,800 mounted pieces and slides, in addition to a large number of objects embedded in paraffin.

Mr. William B. Tegetmeier, the distinguished English naturalist, known for his work on pigeons and other animals and for his cooperation with Charles Darwin in the study of variation, has died in his ninety-seventh year.

Mr. Chester A. Reed, curator of the Worcester Natural History Society and the author of several books on bird life, died at Worcester on December 16.

Mr. Eugene Smith, a Brooklyn engineer, interested in natural science and editor of *The Aquarium*, died on December 25, aged fifty-two years.

Dr. Ernst von Koken, professor of geology at Tübingen, has died at the age of fifty-two years.

Dr. Wilhelm Fiedler, formerly professor of mathematics in the Zurich Technical School, has died at the age of eighty years.

M. Aimé Pagnoul, formerly director of the Agricultural Station at Pas-de-Calais, has died at the age of ninety years.

The examination for the position of curator of the State Natural History Museum of Illinois, recently mentioned in these columns, has been postponed by the civil service commission until January 25, in order to secure more applicants. This is a position which pays $3,000 per year. Applications should be on file in the office of the state Civil Service Commission, Springfield, Ill., not later than January 18.

The next meeting of the International Union for Solar Research will take place at Bonn beginning August 1, 1913.

An international congress for physical education will be held in Paris, March 17–20, 1913, under the auspices of the faculty of medicine. It is expected that the United States will be represented.

In view of the seventeenth International Congress of Medicine, which is to take place in London in 1913, a committee has been formed for the purpose of organizing a museum, and Professor Arthur Keith, conservator of the Royal College of Surgeons' Museum, has been chosen chairman. Accommodation has been secured at the Imperial College of Science, South Kensington, and the museum will be arranged in this place as far as is possible in correspondence with the sections of the congress. It has been decided that, as the meeting is to take place in London, and as the visitors will doubtless desire to inspect the metropolitan hospitals and other great institutions, material will not be collected from the museums of the metropolis. The committee

are therefore seeking exhibits from provincial institutions and from private collections.

IT is stated in the British *Geographical Magazine* that the Paris Society of Natural Sciences has succeeded in making all arrangements for the establishment of a magnificent national park, of which an account was given by Dr. Paul Sarasin at the September meeting of the society at Altdorf. The park is situated in the canton Grisons, in the lower valley of the Inn, near Zernetz, and consists meantime of an uninterrupted stretch of land about forty square miles in extent, which it is hoped later to increase to nearly eighty square miles. All this vast territory will be wholly withdrawn from human interference, and set aside as a biological preserve. It contains at present chamois, a few bears, and a rich flora. Some paths are to be made, together with blockhouses to suppress poaching, and regular observations will be undertaken. Part of the territory has been leased for twenty-five years, and the rest for ninety-nine years, and the cost of rent, surveillance, and observations are to be defrayed out of the funds supplied by a popular league, with a very low annual subscription.

IT will be remembered that at the Dundee meeting of the British Association in September last the president of the Zoological Section, Dr. P. Chalmers Mitchell, F.R.S., took as the subject of his address "The Preservation of Fauna." At the close of the meeting the general committee passed on to the council, for consideration, a resolution, which has now been adopted in the following terms:

That the British Association for the Advancement of Science deplores the rapid destruction of fauna and flora throughout the world, and regards it as an urgent duty that steps should be taken, by the formation of suitably placed reserves, or otherwise, to secure the preservation of examples of all species of animals and plants, irrespective of their economic or sporting value, except in cases where it has been clearly proved that the preservation of particular organisms, even in restricted numbers and places, is a menace to human welfare.

THE thirtieth expedition of the Liverpool School of Tropical Medicine, under Dr. Harald Seidelin, of the Yellow Fever Bureau of the school, sailed from Southampton for Jamaica on December 17. The main object of the expedition is to investigate the disease called "vomiting sickness," which is often fatal to children. The expedition has been promised the support of the English government and of the government of Jamaica.

THE Ohio Academy of Science held a successful meeting at the Ohio State University from November 28 to 30, 1912. The program contained about fifty papers on various subjects in the fields of zoology, botany, geology and physics. The physicists organized a new section in the academy during the past year and participated in the program of this annual meeting for the first time. Eleven papers on various subjects in physics were presented. Mr. Emerson McMillin, of New York, renewed his annual donation of $250 for research work to be conducted under the auspices of the academy. This gift has been continued for a number of years and has been the means of assisting a large number of important scientific investigations. The Biological Survey of Ohio, which was organized during the past year through the cooperation of the Ohio State University and fourteen other colleges of the state, was heartily commended by resolution and the earnest support of the academy was pledged to the undertaking. Another resolution of importance adopted by the academy was one calling for legislation by the state to prevent the propagation of the feeble-minded, insane and habitual criminal. Professor L. B. Walton, of Kenyon College, Gambier, and Professor E. L. Rice, of Ohio Wesleyan University, Delaware, were elected president and secretary, respectively, for the coming year.

THE University of Minnesota is offering a series of lectures upon "Modern Developments in Science." These lectures are given by members of the regular staff of instruction, on Wednesday evenings, in the chemistry building. The program of the series follows:

November 13—"Practical Applications of the Gyroscope," Assistant Professor B. L. Newkirk.

November 20—"Comets I have Known," Professor F. P. Leavenworth.

November 27—"Thunder and Lightning," Professor John Zeleny.

December 4—"Radium, its use in Physics and Medicine," Assistant Professor Alois F. Kovarik.

December 11—"Electrical Transmission of Intelligence," Professor G. D. Shepardson.

December 18—"Some Advances in Modern Bridge Engineering," Professor Frank H. Constant.

January 15—"The Air We Breathe," Dean George B. Frankforter.

January 22—"A Geological Exploration in Southwest Colorado," Professor W. H. Emmons.

January 29—"American Metal Mining," Professor Chas. E. van Barneveld.

February 5—"Geographical Studies in Glacier National Park," Assistant Professor E. M. Lehnerts.

February 19—"The Influence of the Study of Fossils—Paleontology," Assistant Professor F. W. Sardeson.

February 26—"Heredity and Eugenics," Professor H. F. Nachtrieb.

March 5—"Plants and the Cost of Living," Professor F. E. Clements.

March 12—"Sickness in Plants—Causes and Remedies," Professor E. M. Freeman.

March 19—"Modern Warfare against Grasshoppers; and Protective Coloration and Mimicry of Insects," Professor F. L. Washburn.

April 2—"Some Recent Developments in the Study of the Nervous System," Professor J. B. Johnston.

April 9—"The Special Child," Professor J. B. Miner.

April 16—"Recent Progress in the Study and Cure of Cancer," Dr. H. E. Robertson.

April 23—"Modern Surgery," Dr. A. T. Mann.

April 30—"The Two Most Important Epochs in the History of Modern Medicine: the Discovery of Vaccination and the Discovery of the Relation of Microorganisms to Disease and the Application of the Antiseptic Principle to the Practise of Surgery," Dr. Burnside Foster.

May 7—"Living with Head Hunters," Professor Albert E. Jenks.

We learn from the *Geographical Journal* that the attention directed of late years to the antiquarian remains at Tiahuanacu has led the Bolivian Minister of Public Instruction, at the instance of Señor Ballivián, to provide funds for the systematic excavation of the site of the ruins, with a view to saving them from further depredations of a kind to which they have been subject in the past. The work has been carried out under the supervision of the director of the National Museum, Dr. Otto Buchtien, and a report on the results so far gained has been circulated by Señor Ballivián. At a depth of from 3 to 10 feet below the surface a large quantity of pottery was found, of pre-Inca age, many of the objects being in a perfect state of preservation. They at once rivet the attention by the fineness of the material, and in the case of the cups, bowls, etc., by their artistic form as well as by the excellence and freshness of the coloring. The diversity of the ideographs and pictographs represented on them will demand special study by experts. Among the smaller objects, a human figure in silver is interesting as showing the nature of the garments worn in that ancient time. Worked stones have also been found, and skulls showing distinct traces of deformation. One of the latest discoveries had been a skull, belonging apparently to an ancient race, and showing the frontal suture and larger in all its dimensions than skulls of the present day. Further reports are promised as the work progresses.

UNIVERSITY AND EDUCATIONAL NEWS

The Hamburg senate has adopted the proposal to found a university there consisting of three faculties—law, philosophy and colonial science. These are to be supported by the interest on $6,250,000, which has been appropriated for the purpose by the city.

The program for the exercises at the dedication of Lincoln Hall, University of Illinois, to be held on February 12, includes addresses by Mr. Hugh Black, Governor Deneen and Bishop McDowell of Chicago. Lincoln Hall was made possible by an appropriation of $250,000 by the legislature in 1909, the one hundredth anniversary of Lincoln's birth and it was decided to give the building its present name and dedicate it to the study of humanities.

DR. BURT L. HARTWELL, professor of agricultural chemistry in the Rhode Island State College, has been appointed director of the station to succeed Dr. Homer H. Wheeler, who recently resigned.

MR. E. G. ARZBERGER, H. R. Watts, J. B. Demaree, L. E. Melchers and J. T. Rogers, assistant botanists in the botanical department of the Ohio Agricultural Experiment Station, have resigned from their positions.

DR. J. W. NICHOLSON, M.A., Trinity College, Cambridge, has been appointed professor of mathematics in London University, being attached to King's College.

DR. W. H. PERKIN, F.R.S., professor of chemistry at Manchester University, has been elected Waynflete professor of chemistry at Oxford. A grant of £15,000 towards the erection of the new chemical laboratory, as well as a further loan, has been promised by the trustees of the chancellor's endowment fund.

DISCUSSION AND CORRESPONDENCE

A NEW WEED EXTERMINATOR

WILD garlic (*Allium vineale*) has become a serious farm pest, especially in the belt of territory extending from Maryland to Missouri. Beside having the usual competitive action as a weed in cultivated fields, the presence of bulblets in wheat lowers the market value, as the bulblets are about the size and color of the grains, and difficult to separate. The weed also gives an unpleasant taint to the milk and flesh of animals feeding on the leaves, and to flour made from wheat containing the bulblets.

Owing to the remarkable tenacity of life possessed by the bulbs and bulblets no practical method to rid the soil of the pest has heretofore been found, and in some localities fields have been abandoned and given over to the weed.

Nearly two years ago an investigation of the wild garlic was taken up as a special problem by the Botanical Department of the Indiana Experiment Station. The field tests were carried on in cooperation with Dr. H. E. Horton, agronomist of the American Steel & Wire Co., and Mr. Jacob Cronbach, of Mount Vernon, Ind. After various chemical sprays and cultural methods had been tried to little purpose, Mr. F. J. Pipal, assistant botanist in the Indiana Station and in direct charge of the work, suggested the use of orchard heating oil, as supplied by the Standard Oil Co., applied as a spray.

Remarkable results were obtained from the beginning of the tests. It was found that when the oil was distributed over the field in a fine spray by a sufficiently powerful spraying machine, that all growing vegetation was killed, not only above ground but below ground as well, except the long horizontal rootstocks of such plants as *Tecoma radicans* and *Solanum carolinense*, and the extra large roots of such plants as *Ipomœa pandurata*, the latter requiring a correspondingly larger amount of oil. It destroyed the bulbs of the wild garlic, however deep below the surface, and the bulblets at the tops of the stalks as well. The oil appeared to produce no lasting effects upon the soil, and new growth from seeds already in the soil and from subsequently sowed cereals possessed the usual vigor. The best times and methods for the application are now being tested.

The introduction of this new material for killing weeds is accompanied by a new method of application. Heretofore chemical sprays have been differential, and intended to kill only the weeds while leaving the crops essentially unharmed. Orchard heating oil acts as a complete spray, killing all vegetation, like plowing or fire, only more effectively than these, as it follows the stems and roots well into the ground.

J. C. ARTHUR

INDIANA EXPERIMENT STATION,
PURDUE UNIVERSITY

GREEK REFINEMENTS IN ARCHITECTURE

THE existence of subtleties of line and spacing in Greek architecture is now well known. A very interesting point is how much of the classic practise was lost in the Dark Ages and how much preserved. The following extract from "Evelyn's Diary" seems to bear upon the point. It shows, at least, that

similar problems were familiar to English architects of the seventeenth century.

1666, Aug. 27, I went to St. Paule's church, where with Dr. Wren, Mr. Prat, Mr. May, Mr. Thos. Chichley, Mr. Slingsby, the Bishop of London, the Deane of St. Paule's and several expert workmen, we went about to survey the general decays of that ancient and venerable church, and to set downe in writing the particulars of what was fit to be don, with the chargo thereof, giving our opinion from article to article. Finding the maine building to recede outwards, it was the opinion of Mr. Chichley and Mr. Prat that it had been so built *ab origine* for an effect in perspective, in regard of the height; but I was, with Dr. Wren, quite of another judgment, and so we entered it; we plumb'd the uprights in severall places. . . . (From Evelyn's Diary.)

EDWARD S. HOLDEN

WEST POINT, N. Y.,
November, 1912

THE QUESTION OF THE OLDER AND NEWER APPALACHIANS

IN a lucid and valuable article on the geography of the United States, Professor Wm. M. Davis divides the Appalachians[1] into an older eastern and a newer western belt. He makes in New England the Taconics and the great limestone valley the newer, and all the rest of New England from and including the Green Mountain range the older. By this he means composed mainly of older rocks.

The distinction is good, but the names should be reversed for New England.

The western division contains mainly Cambrian and Ordovician rocks. A narrow interrupted band of Archæan forms the west border of the eastern band, going south from the Hoosac Tunnel. Next east is a band of the Hoosac and Rowe schists, which are correlated with the Berkshire schist of the western division and so are Ordovician. Next east is the much broader band of the "Calciferous Mica Schist" (the Goshen and Conway schists), which extends to the Connecticut Valley, and widens northerly into Canada, carrying Silurian fossils. Next east is the Bernardston Devonian, underlying the Connecticut Valley and in part covered by Trias. The whole of Worcester County is Carboniferous, cut by late Carboniferous granites. The new discovery of Carboniferous fossils in Worcester by David White reënforces Perry's earlier finds, and all the Carboniferous rock types occur in the eastern rim of the Connecticut Valley, and all the intervening country can be connected by transitions with the undoubted Carboniferous.

East of Worcester is a narrow seaward band of Algonkian and Cambrian greatly covered by Carboniferous, so that about nine tenths of the area between the Housatonic Valley and the sea is covered by rocks newer than those of this valley and the Taconics.

This change of name does not lessen the great value of the distinction, which is based not so much on age as on the presence of the great limestone in the western belt and its lesser metamorphism, which has caused great differences in the topography. The lesser metamorphism of the western belt depends, in part, on the absence of granite which has overwhelmed all the area of the eastern belt. They have both been subjected to the same folding and uplifting agencies, but the overthrust faulting along the east border of the limestone valley has had for an effect that less and more varied pressure was transmitted westwardly, while the greater pressure in the east has not only caused greater metamorphism across central New England, but the extensive intrusion of various granites has greatly increased this metamorphism, and has left a country where a very broad meshed network of Carboniferous schists rests in great areas of carboniferous granite.

The eastern division, which has for its western border the Green and Hoosic Mountains, constitutes the New England Province, and, taken as a whole, has an interesting balanced arrangement. The ancient Green Mountain protaxis made up of Archæan to Ordovician rocks is balanced on the east by the equally ancient Nova Scotian series, which is lithologically similar, and both are gold bearing.

Next inwardly the narrow fault bounded

[1] Mill's "International Geography," pp. 717–732.

Connecticut Valley depression with its Triassic traps and sandstones stands over against the similar narrow Triassic basin of the Bay of Fundy, continued in the Boston and Narragansett basins. There remains the broad central New England Plateau, made up of great late-Carboniferous granite batholites running north and south, or with a little easting and isolated by bands, often very narrow, of late Paleozoic rocks, largely Carboniferous.

The series of batholites in this central plateau is itself symmetrically arranged and becomes more basic from the center outwardly.

Crossing the center of the plateau from north to south is the broad Hubbardston-Princeton band of granite which is truncated by erosion so nearly along its contact with the cover of Carboniferous schists, that it is everywhere contaminated with the sillimanite and graphite of these schists, and is made coarsely pegmatitic from the water obtained from them.

Next on the east is the long train of oval batholites running through Worcester, the Ayre series, which are of uniform porphyritic texture, and are matched on the west by the coarsely porphyritic Coy's Hill series, passing east of Ware.

Next outwardly the dark biotite Bolton granite-gneiss on the east is matched by the broad band of the black Hardwick biotite granite, passing through Ware.

Then follows on the east the fine-grained Milford biotite granite, so valuable as a building stone, which is comparable with the Monson and Pelham biotite granites on the west, which are also extensively quarried.

Finally, the complex Quincey-Dedham series of igneous rocks along the eastern border of the area, with its basic and soda-rich rocks, is balanced by the basic Belchertown series, which is a counterpart of the Cortlandt series, and borders the plateau on the west. Each marks the locus of a principal fault system which form, respectively, the eastern and western limit of the plateau. By contrast faulting is wanting or inconspicuous in all the central portion of the province.

B. K. EMERSON

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SCIENTIFIC BOOKS

Oxidations and Reductions in the Animal Body. By H. D. DAKIN, D.Sc., F.I.C., The Herter Laboratory, New York. Longmans, Green & Co., New York. 1912. Pp. viii + 135. Price $1.40 net.

For some time in the past, "energy" has been the keyword of the theories of nutrition. The problems presented in relation to the transformation of energy in the body were so conspicuous and the technique of investigation so effectively improved in application to the study of the metabolism of energy, that other aspects of the subject were neglected. This trend of the science is reflected in the popular literature of the present time when expressions like "calories" and "fuel value" are employed with the skill of the conjurer to impress the uninitiated. The mere comparison of the intake and the output of the organism and the broad statement that metabolism is essentially a process of oxidation change has, however, long since failed to satisfy the more critical inquirer; and accordingly the questions of what is now termed intermediary metabolism, concerned with the destiny of the individual nutrients or corresponding tissue components, are forging to the front. The newer knowledge of the chemistry of the digestive processes has made great strides in a decade or two. Yet how little we know of the various steps beyond the barrier of the intestinal wall.

It is of certain of these intricate processes considered primarily as chemical reactions that the present monograph aims to give an account. The animus of the attempt at what is essentially a novelty in the literature of physiology may be elicited from a few quotations. Dakin writes:

The statements that fats and sugars are oxidized in the body to carbon dioxide and water, while proteins yield urea in addition, are no longer considered all-sufficient explanations of the chemical rôle of these substances in the animal economy. The study of chemical structure is rapidly changing the whole aspect of biological science, and we may confidently look forward to the time when the orderly succession of chemical reactions consti-

tuting the activities of the living cell will be resolved into their individual phases. . . . It is relatively easy to obtain a balance sheet representing the intake and output of substances in the animal body, but what is fundamentally necessary for the proper appreciation of this balance sheet is a knowledge of the various chemical transactions which (to continue the simile) should be comprised in a trading account. For it is by the proper adjustment and regulation of these transactions that the energy represented by food and tissue substance are economically utilized according to the varying needs of the body. The rapidly developing appreciation of the fact that different proteins, fats and sugars are not physiologically equivalent but that certain definite chemical groups subserve special functions in the animal organism emphasizes the necessity of the study of intermediary metabolism. . . . A true knowledge of metabolic processes can only be obtained by the tedious unravelling of the complex system of biochemical changes into individual chemical reactions. At the present time only a few of these simple reactions have been recognized and studied, but even now it requires little imagination to realize that in the future it will be possible to construct an accurately itemized account of the animal body's chemical transactions, both anabolic and catabolic. The value of such knowledge for the advancement of biology and medicine is sufficiently obvious.

Dakin's book emphasizes the fact that many of the striking biochemical reactions can already be imitated to-day more or less successfully by experiments in vitro. This is, of course, a helpful assurance, serving to divert attention from vague speculation regarding subtle vital forces. It has been a popular practise to appeal to hypothetical enzymes to explain some of the obscure chemical transformations in the organism. Thus we have been wandering through the mazes of the oxidases, oxygenases, peroxidases, reductases, catalases and other products of perplexing nomenclature in the hope of escaping the uncertainties of intermediary metabolism. Much of the obscurity is at length dispelled by a vigorous presentation in which questions of chemical structure are paramount and details of biological processes are exemplified in actual experiment or by clear analogy.

In connection with the oxidative capacity of the body Dakin points out the accumulating evidence in favor of the hypothesis of superoxide formation in living cells. With regard to the possibility of biochemical reductions reference is made to the interesting Cannizzaro reaction whereby the reduction of one molecule of substance takes place with the simultaneous oxidation of a second molecule, according to the scheme:

$$2\,R\cdot CHO + H_2O = R\cdot CH_2OH + R\cdot COOH.$$

A brief chapter on the methods of investigation formulates the attitude of mind with which the student of intermediary metabolism approaches his problems. It is a decidedly exceptional outline of the viewpoints which may guide the worker in this field in the direction of successful experimentation.

Pointing out that it is only since the publication of Knoop's important studies in 1904 that any material progress has been made in the experimental investigation of fatty acid katabolism, Dakin subjects Knoop's theory of β-oxidation to a critical analysis. He shows that chemical analogies for this are found in the behavior of fatty acids towards hydrogen peroxide, so that by the choice of a suitable oxidizing agent the occurrence of β-oxidation can readily be demonstrated *in vitro*. Physiological experiments continue to furnish striking confirmation of the theory. The relative importance of the β-hydroxy- and β-ketonic acids in the mechanism of the reaction are discussed with abundant reference to the growing illustrative literature to which the author of the monograph has furnished prominent experimental contributions. Other types of reaction than that of β-oxidation have not yet been observed, and it is not likely that α-oxidation of normal saturated fatty acids takes place in the animal body.

In turn the behavior of the unsaturated acids, the oxidation of acids with branched chains, the dibasic acids, aromatic compounds, amino-, hydroxy- and ketonic acids are reviewed. The intimate biochemical relation

of the latter groups, illustrated by the scheme,

$$CH_3 \cdot CHNH_2 \cdot COOH \rightleftarrows CH_3 \cdot CO \cdot COOH \rightleftarrows CH_3 \cdot CHOH \cdot COOH,$$

furnishes a text for the discussion of some of the manifold metabolic performances that have only lately found a place in physiological speculations. The oxidation and reduction of amino-acids by microorganisms, with reference to the splendid newer work of F. Ehrlich and of Neuberg in this field, is presented in novel, though brief form. In his treatment of the behavior of the carbohydrates Dakin champions the view that lactic acid must be regarded as one of the most important substances concerned with their intermediate metabolism. There are further chapters on the purines, hydrocarbons, phenols, etc.; and in conformity with the plan of the series of monographs on biochemistry to which this book belongs there is a well-arranged bibliography appended.

The frankness with which open questions are presented, as illustrated in the debated respective rôles of β-ketonic and β-hydroxy acids, is wholesome and marks the unbiased attitude of the book's author, even where his own researches are involved. The reader is impressed with the great advances which have lately been made in the new field covered by this monograph; and whether his interests are primarily those of the physiologist or the chemist, he will be stimulated by the wealth of suggestions—all presented there in a readable form.

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The North American Dragon Flies of the Genus Æshna. By E. M. WALKER. University of Toronto Studies. 1912.

It occasionally happens that some familiar group of animals is investigated by one who is sufficiently skilled and independent to detect characters which have escaped all previous observers. I recall the time, now a quarter of a century ago, when certain common land molluscs were added to the British list. One of these was almost literally in every one's garden, but until its distinctive characters were pointed out, nobody could see it. To-day the merest beginner can recognize it at once. We are forced to conclude that even excellent manuals are not without their disadvantages, when they are blindly followed by naturalists, who will not even look for things unmentioned by them. The same sort of thing has been very evident in botany, and we have in Mr. Walker's work a remarkable exposure of blindness in the field of entomology. Mr. Walker, during the summer of 1906, was at Lake Simcoe, Ontario, where he interested himself in the common large dragon flies of the genus *Æshna.* Most people would have viewed them with languid interest as being among the "familiar objects of the country side," completely exploited by entomologists long ago. Not so Mr. Walker, who with critical eye presently discerned that there were more species than the books called for. His curiosity thus stimulated, he pursued the subject further, and was eventually able to establish the existence of sixteen perfectly valid species in temperate North America, five of them described as new by himself. While doing this he has monographed the genus as represented in this country, and now publishes a most exhaustive treatment, discussing the biology, early stages, geographical distribution and other matters. The work is also fully illustrated, with 28 plates and some good text figures. Only one thing seems lacking: I find no mention of Scudder's *Æshna solida,* which is represented by such beautifully preserved wings in the Miocene shales at Florissant.

The interesting fact is brought out that in addition to "structural" characters, each species has its own color-pattern, which may at once be recognized when known. It is also found that the immature forms, the nymphs, have characters of their own, which are duly set forth in a key. It is thought probable or possible that the genus *Æshna* is of polyphyletic origin, the *californica* group especially having perhaps a different origin from the

rest. In *Entomological News*, 1908, p. 458, I gave reasons for thinking that *A. californica* deserved subgeneric rank; Mr. Walker's results appear to support this idea, and even suggest the question whether it should not be generically separated, taking with it several related forms.

Certainly Mr. Walker's book should be in every biological laboratory, both as an example of good taxonomy and as a useful work of reference, *Æshna* being common nearly everywhere.

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SPECIAL ARTICLES

A PRELIMINARY NOTE ON THE COAGULATION OF PROTEINS BY ULTRAVIOLET LIGHT

In order to gain some insight into the action of ultraviolet light on living cells it became necessary to study its effect on certain constituents of protoplasm. Attention was first given to proteins and a series of experiments were made with egg-white, egg albumin and ox-serum.

1. *Experiments with Egg-white.*—Fresh egg-white was cut up with scissors and placed in a quartz tube, at room temperature, 10 cm. from a quartz mercury-vapor lamp. The tube was completely filled and stoppered. After 1 or 2 hours a feathery coagulum began to form in the tube upon the wall nearest the lamp. This coagulum increased in amount, and after 35 hours the tube was quite full of a flocculent coagulum. There was a peculiar strong odor.

Fresh egg-white was diluted with an equal amount of distilled water. The solution became opalescent from the precipitated globulin. The tube was exposed at room temperature in the same manner as the tube containing the undiluted egg-white. There was a similar coagulation, but it was more abundant. There was also the same peculiar odor. In this case the coagulum slowly settled as it formed. The solution, therefore, was clearer, and there may have been a better penetration of the light. In another experiment the precipitated globulin was filtered out before exposure. Fifteen hours after filtering, the solution was still clear. On exposure to the light a fine sediment was formed which slowly settled to the bottom of the tube. The characteristic odor was present.

In all the experiments described above control preparations in glass tubes, exposed in the same manner, and at the same temperature, gave little or no coagulum, and none of the characteristic odor. The coagulum formed in the quartz tubes, whether they were open or closed. It formed equally well in tubes which had been connected with the air-pump and pumped out so as to remove the dissolved air. No bubbles of gas were formed during the exposure, nor could gases be detected in the solution by pumping with the air pump after the exposure.

2. *Experiments with Crystallized Egg-albumin.*—Crystallized egg-albumin was prepared by the method described by Hopkins and Pinkus. The egg albumin was recrystallized seven times. The ammonium sulfate which came down in the last crystallization was not dialyzed out. Solutions were prepared containing 1, 2, 5, 10 and 20-per-cent. of the albumin. All were exposed in quartz tubes at room temperature. The 5-per-cent. solution gave the most coagulum and in subsequent experiments with crystallized albumin 5 per cent. solutions were used. Coagulation was much more rapid in the crystallized albumin plus the ammonium sulfate, than in the fresh egg-white.

3. *Experiments with Crystallized Egg-albumin Dialyzed Against Tap Water.*—Albumin freed from ammonium sulfate by dialyzing against tap water coagulates very readily when exposed to the light at room temperature. It may be sensitive to longer wavelengths than the fresh egg-white, since considerable coagulum forms in the glass tubes. A quartz and a glass tube were exposed at room temperature for 15 hours. The quartz tube became opalescent and then opaque with a finely divided coagulum which did not settle, but which could be thrown down with a centrifuge. A feathery coagulum formed in the glass tube on the side nearest the lamp. This increased in amount, until the tube was filled

with a feathery coagulum. When the tube was moved, the coagulum separated from wall of the tube and settled to the bottom, leaving the solution in the tube perfectly clear. Further exposure of 20 hours produced only one or two scarcely visible masses of coagulum in the clear solution above the coagulum at the bottom of the tube. The solution contained, however, an abundance of albumin which could be coagulated by heat.

4. *Experiments with Ox-serum.*—The serum was prepared by allowing a clot to form and then decanting off the clear liquid. A portion of this was placed in a quartz test tube and exposed to the light at room temperature. As in the other cases a coagulum formed in the quartz tube while none formed in the glass tube which was exposed at the same time.

The coagulum produced by the light in egg-white and egg-albumin is insoluble in alcohol, hot or cold water and dilute acids. It is soluble in dilute alkalies. In these respects it agrees with the ordinary coagulum which is produced by heat without exposure to ultra-violet light.

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ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA

THE fourteenth meeting of this society was held at the Allegheny Observatory and the Schenley Hotel, Pittsburgh, from Tuesday to Friday, August 27–31, 1912. Sessions were held at the Observatory on Tuesday and Wednesday, the afternoon of Wednesday being occupied by the exercises of dedication of the new observatory. On Thursday and Friday sessions were held at the Schenley Hotel. An excursion to the Homestead Steel Plant of the Carnegie Steel Company, and a visit to the Carnegie Institute added much to the pleasure of the meeting.

The following members were in attendance: A. T. G. Apple, R. H. Baker, L. A. Bauer, B. Boss, J. A. Brashear, Miss Annie J. Cannon, G. C. Comstock, Z. Daniel, H. S. Davis, A. E. Douglass, W. S. Eichelberger, Philip Fox, Edgar Frisby, Miss Caroline Furness, William Gaertner, Miss A. M. Harwood, F. C. Jordan, T. A. Lawes, F. B. Littell, R. J. McDiarmid, J. B. McDowell, D. B. Marsh, J. A. Miller, O. L. Petitdidier, E. C. Pickering, J. S. Plaskett, A. W. Quimby, H. Raymond, E. D. Roe, Jr., H. B. Rumrill, F. Schlesinger, W. L. Scaife, H. Shapley, A. N. Skinner, F. Slocum, Elliott Smith, C. E. St. John, DeLisle Stewart, R. M. Stewart, Miss Helen M. Swartz, S. D. Thaw, Miss Stella May Udick, C. E. VanOrstrand, Miss Sarah F. Whiting.

Visiting astronomers: Louise S. Smith, A. van Maanen.

The following new members were elected: Miss Stella May Udick, Messrs. Harry Raymond, James Hartness, Arthur Newton, Henry G. Gale, David Rines, E. S. Haynes, William L. Scaife, James B. McDowell.

The constitution of the society was amended to provide for the election of honorary members. In accordance with the provisions of the amendment, nominations were received. Sir David Gill was unanimously elected the first honorary member of the society.

The council voted to hold no meeting in the summer of 1913, because of the probable absence of a number of the members in attendance at the Solar Union meeting at Bonn. The next meeting will be in Cleveland during the holidays, 1912, in connection with the American Association for the Advancement of Science. The council voted to hold the 1914 summer meeting at Northwestern University and the 1915 meeting in San Francisco and at the Lick Observatory.

Officers were elected:

President—E. C. Pickering.

First Vice-president—G. C. Comstock.

Second Vice-president—Frank Schlesinger.

Secretary—Philip Fox.

Treasurer—Miss Annie J. Cannon.

Councillors 1912–1914—W. W. Campbell, E. B. Frost.

The councillors who continue to serve are:

Councillors 1911–1913—W. S. Eichelberger, J. S. Plaskett.

Abstracts of the committee reports and forty-six papers which were read follow:

Irregularities in Atmospheric Refraction: FRANK SCHLESINGER.

This investigation was suggested by the recent work of Nusl and Fric at Prague, who found evidence of irregularities in refraction in a period that is roughly one minute, and having considerable amplitude. At the present author's request Professor Slocum, of the Yerkes Observatory, kindly secured with the 40-inch refractor a number

of plates showing trails of the Pleiades. These plates were exposed on several different nights. Proper precautions were taken to leave the telescope as undisturbed as possible. The trails were measured at the Allegheny Observatory by setting the micrometer wire on the mean position of successive portions of the trail, each corresponding to an interval of about three seconds of time. It was found that on each evening the trails conclusively show the presence of irregular refractions, portions of the trails remaining on one side (of the mean position for that plate) sometimes nearly a minute. On two of the plates simultaneous trails of Alcyone and Merope were measured and these show a remarkable parallelism. The result of this experiment tends strongly to confirm the deductions of Nusl and Fric.

The Orbit of R Canis Majoris: FRANK C. JORDAN.

This star, one of the few Algol variables with an advanced type spectrum, *F*, was discovered to be a light variable, by Sawyer in 1887, and to have variable radial velocity, by Frost in 1905. Forty-nine plates have been obtained at Allegheny in five seasons of observation. The light period has been very accurately determined and is taken as the definitive orbital period.

The elements are as follows: $P = 1.13595$ days; $e = 0.138$; $\omega = 195°.86$; $K = 28.64$ km.; $\gamma = -43.45$ km.; $T = 1908$, Jan. 25.296, Light Minimum; $a \sin i = 453{,}500$ km.; $m'^3/(m+m')^2 = 0.00288\ \odot$.

Accurate photometric observations combined with the orbital elements, and the fact that the spectrum is much like that of our sun, will give an independent means of finding the star's parallax.

New Eclipsing Variable Stars: JOEL STEBBINS.

It is probable that a considerable number of the short-period spectroscopic binaries are eclipsing variable stars, and the writer reports progress on tests of these systems with the selenium photometer. It seems practically certain that α Virginis and α Coronæ Borealis are such variables, and β Scorpii is suspected. The first, Spica, has a period of 4.014 days, and shows two minima, a primary of something greater than 0.10 mag., and a secondary of about 0.08 mag. The main eclipse of α Coronæ was observed only once, but it was a decrease of at least 0.12 mag., and came at the predicted time. This star is a member of the extended Ursa Major group, and has a period of 17.36 days. The suspicions of the variation of β Scorpii seem well founded, but need confirmation.

The results emphasize the urgent need of further tests on similar stars.

The Scale of the Durchmusterung: E. C. PICKERING.

The number of stars in the Bonn Durchmusterung is about 460,000; in the Cordoba, 490,000; in the Cape, 450,000; total, 1,400,000, or, omitting duplicates, 1,100,000 stars. In the *Harvard Annals*, **23**, the deviations, from the photometric scales, of the magnitudes 9.0 and brighter are discussed. Volumes **70** and **74** permit a similar study of the fainter stars and of those in the Cordoba Durchmusterung whose average brightness differs as much as a magnitude in different hours, the brightness increasing as the number of stars per degree increases. The photometric magnitude of Bonn 9.5 is 10.5; of Cordoba 10 it is 12.0 in zones $-22°$ to $-42°$, and 11.7 in zones $-43°$ to $-52°$. Stars of a given Durchmusterung magnitude are half a magnitude brighter in zones $-43°$ to $-52°$ than those in the zones $-22°$ to $-42°$.

The deviations of the Cape Durchmusterung magnitudes from the photometric magnitudes are reduced one half by grouping stars on the same plate and applying a correction for the class of spectrum. The average deviation in a provisional reduction of 12 plates is only ± 0.2 mag.

The Progress of the Revised Draper Catalogue: ANNIE J. CANNON.

The purpose of this catalogue is to give the class of spectrum of all stars down to about the eighth magnitude, distributed over the entire sky. Photographs having exposures of sixty minutes have been made at Cambridge and Arequipa with a prism of small angle placed before the objective of 8-inch doublets, and all stars will be classified which are bright enough to be seen clearly and have not already been published in *H. A.*, **28**, and *H. A.*, **56**, 4 and 5. Besides the classification the catalogue will give the photographic magnitude, the identification in some position catalogue, and the place for 1900. The catalogue was started in October, 1911. With an hour's observation each day, about 5,000 spectra can be classified in a month. This rate has been maintained since February, 1912, so that at the beginning of August, 45,000 stars have been classified. Charts were exhibited showing that about one third of the sky has been covered.

A Design for a New Form of Spectrograph Collimator: PHILIP FOX.

This form was proposed for use with the small

quartz spectrograph of the Yerkes Observatory. As the spectrograph was to be used with the 2-foot reflector, of which the angular aperture is $f/4$, the collimator should also have such ratio. The form proposed is in all essentials a small reflector of the cassegrain form. The light coming through the slit falls on the perforated concave mirror, which throws the light upon a small perforated convex mirror, mounted just back of the slit. This second mirror is of such curvature that it throws a parallel beam through the perforation of the first mirror upon the prism. The ratio of perforation to aperture in both cases is equal to the ratio of aperture of the objective of the telescope to the diagonal mirror, and the aperture of the convex mirror is equal to the perforation of the concave, so there is no loss of light. The perforation of the convex mirror centered behind the slit is of sufficient size to permit the use of a slit one eighth of an inch long.

Systematic Motions of the Stars: BENJAMIN BOSS.

Diagrams representing the distribution of stars of the different spectral types and down to the 6.5 magnitude were exhibited. The striking preference of the *B* type stars for the plane of the galaxy, the similar, though somewhat less pronounced, preference of the *A* type for the same plane, and the more random distribution of the more advanced types was clearly shown. We must either conclude that eventually a state of approximately random motion must prevail, or that the later type stars originated uniformly over the entire sky, rather than selecting the plane of the galaxy. The facts revealed by the study of the motions of the stars indicate that the first view is the correct one (*A. J.*, 635–636). The early type stars show a decided crowding toward certain portions of the galaxy, toward the vertices of preferential motion, as discovered by Kapteyn, and toward the apex and antapex of a group of stars called Group IV., or the antapex group, discovered by the writer (*A. J.*, 635). That the motion of this group is in the direction of the antapex of solar motion, and that there seems to be a tendency of motion in the opposite direction, may indicate the existence of a solar group. The analysis of the motions within these groups is now in process of development by the writer.

Observations of Variable Stars at the Vassar College Observatory: CAROLINE E. FURNESS.

Observations of variable stars were begun at this observatory in 1901. The telescopes in use had apertures of twelve, five and three inches. A photographic wedge photometer which could be attached to the twelve-inch was in use for part of the time, but for the most part the comparisons were made by the Argelander method. The observing list included chiefly long-period variables which were selected so that they might pass through a maximum or minimum during the time of observation. The predictions were usually taken from Hartwig's ephemeris. The standard of magnitude was the Harvard photometry, other sources being reduced to this scale.

The resulting observations, about five thousand in number, with a full discussion of the curves and periods of the stars so far as they may be determined, are to be published as soon as their revision is complete.[1]

On the Cause of the Earth's Magnetic Field: L. A. BAUER.

The communication is confined to a consideration of the portion of the field which is symmetrical about both the axis of rotation and the equator. If the intensity of the magnetization be computed for each parallel of latitude over the region best covered by magnetic observations, 60° N. to 60° S., on the basis that the average values of the observed magnetic components along a parallel correspond to those of a uniform magnetization parallel to the axis of rotation, then a systematic and regular increase in the intensity is observed in both hemispheres with approach to the equator. This may be stated mathematically thus: If X be the magnetic component along a true meridian, positive toward the north, and Z be the vertical component, positive downward, then for the field, symmetrical as stated, the components, for any co-latitude u, will be

$$X = f_x(u) \sin u \quad \text{and} \quad Z = f_z(u) \cos u.$$

These "characteristic functions" show an increase of 13 to 17 per cent. from the parallel of 60° to the equator.

None of the theories thus far advanced to account for the origin of the earth's magnetic field gives the law of the observed increase in the characteristic functions. With but few exceptions, the attempts have been restricted to ascertaining a cause for a uniform magnetization. Since this course has not led to generally accepted results, it was decided to begin with the geographical variations, hoping that, if their cause be determined, valuable clues might be found as to the origin of the primary field. Thus a closed physical expres-

[1] See *Popular Astronomy*, 20, 645, 1912.

sion was found, consisting of the zonal harmonics of the first and third order, which represents the facts to within one per cent.

Supposing the bound electrical charges in each atom of the earth to be separated by some cause into positive and negative atomic charges an infinitesimal distance apart, such that the total charge throughout the earth of each kind of electricity be equal and the volume density of each charge vary from parallel to parallel as $\sin^2 u$; then, by reason of the earth's rotation, a magnetic field results whose potential is the expression mentioned in the preceding paragraph. The first term corresponds to a uniform magnetization of the earth parallel to its axis of rotation having about one tenth of the strength of the total portion assignable to a uniform field; the second term, consisting of the third order harmonic, reproduces satisfactorily the observed increase in the characteristic functions. If it be assumed that the separating agency is the component of the earth's centrifugal force acting in the direction of the radius away from the center, a distribution of the two opposite electricities throughout the earth would apparently result, following, as a first approximation, the same law of density, supposed in deriving the expression, the zonal harmonics. Before a final statement, however, can be made as to the precise cause, a more complete examination will have to be made and full consideration be given to all the various effects involved.

Radial Motion in Sun-spots: C. E. St. John.

The results obtained to date indicate the following mean conditions:

Element	Line	Intensity	Direction	Vel. in Km. per Sec.
Ca	H, K		Inward	2.5
H	$H\alpha$		Inward	1.4
Na	D		Inward	0.2
Mg	b		Inward	0.3
Al	λ 3961	20	Inward	0.1
Fe	Mean of several near λ 5200	6	Outward	0.40
Fe		5	Outward	0.43
Fe		4	Outward	0.52
Fe		3	Outward	0.61
Fe		2	Outward	0.66
Fe		1	Outward	0.75
Fe		0	Outward	0.84

Results similar to those of iron appear for other metallic vapors producing lines of moderate intensities, though the velocities from lines of equal intensities for different elements are not equal. This offers a means of determining the relative levels at which lines of different intensities have their origin, in terms of some standard such as iron.

Three regions are indicated in the solar atmosphere surrounding spots with the following characteristics at the different levels: (1) The upper chromosphere, motion inward, shown by the H and K lines of calcium and H_a of hydrogen; (2) an intermediate region shown by the D lines of sodium, b lines of magnesium, and the strong aluminum and iron lines, motion inward generally prevailing; (3) a lower region of outward motion, velocity increasing with lower levels, on the assumption that when considered by and large the weaker lines are associated with the lower levels.

Pressure in the Solar Atmosphere: C. E. St. John.

In the new spectrograph of the 150-foot tower telescope the sources of error associated with the instability of the apparatus, the illumination of the grating and the centering of the solar image, have been overcome, the first, by the massive construction of the spectrograph, the head of which weighs about 4,500 lbs.; the second, by the larger diameter, 15 inches, of the cone of sunlight incident upon the grating which the long focus, 75 feet, of the spectrograph permits when the 12-inch objective of 60-feet focus is used to form the solar image on the slit; the third, by fixing the slit rigorously on the axis of the centering circles. The error introduced from non-centering of the image may be large; with the image now used (diameter 162 mm.) the solar lines would be shifted 0.001 Å. by solar rotation when the slit is 2 mm. from the center of the image and on small images the error might be much greater.

With this equipment an investigation involving a comparison of the arc and solar spectra of iron is being carried out. The preliminary results show that the solar lines of iron classified in accordance with their displacement in solar spectrum fall into the classes suggested by Gale and Adams in their study of pressure shift under laboratory conditions and indicate pressures in the solar atmosphere varying from 0.7 to 6.5 terrestrial atmospheres for the different groups.

On the Diurnal Variations of Atmospheric Pressure: W. J. Humphreys.

It has been known for nearly two and a half centuries that there are more or less regular daily variations in the height of the barometer, culminating in two maxima and two minima during the course of the 24 hours; the maxima occurring

at 10 o'clock, roughly, forenoon and evening, the minima at 4 o'clock, roughly, afternoon and morning.

All that is needed, apparently, to give the semidiurnal pressure curve, is a pressure impulse of the same period, 12 hours, as that of the free vibration of the atmosphere as a whole. And this, it seems, is furnished by a forced forenoon barometric maximum, due to the interference of vertical convection with the free flow of the air, followed, six hours later, at the same place by a forced afternoon barometric minimum, caused by expansion and overflow. In other words, taken together the forenoon and afternoon forced disturbances appear to occur with the proper time interval necessary to set up and maintain the 12-hour free vibrations of the atmosphere.

The course of events at each locality, affecting the height of the barometer, appears to be substantially as follows: (1) A forced forenoon compression of the atmosphere followed by its equally forced afternoon expansion; both due to a single heating and the two together forming one complete barometric wave, with a 10-o'clock maximum and a 4-o'clock minimum, in harmony with the free vibration of the entire atmosphere shell. (2) Non-disturbance through the night, or during the period of a single free vibration. (3) Repetition the following day of the forced disturbances in synchronism with, and therefore at such time as to reinforce, the free vibrations. The series of disturbances of course is indefinitely great, alternately forced and alternately free, but the resulting amplitudes of the barometric changes are limited, through friction and through the absence of perfect synchronism, to comparatively small values.

A Screen for Equalizing Star Magnitudes for Transit Circle Work: F. B. LITTELL.

The equalizing screen consists of two sets of thin brass slats at right angles to each other, intermeshed to form a rectangular, honeycomb structure. The slats are 1/2 inch wide, 1/120 inch thick and 1/5 inch apart, and make an angle of 45° to the plane of the meridian. The whole is mounted about 3 inches in front of the objective and may be tilted about an axis parallel to the horizon, the operation being effected and the amount read at the eye end. The light which falls on the objective is evenly distributed in nearly rhombic areas. A tilt of 30° gives total extinction. The bright spectral images formed by the bright stars which vary in character with the setting of the screen can be rendered practically invisible in a bright field by preliminarily reducing the light by means of one or both of the two wire mesh screens which have been used on the instrument for several years and which are retained for this purpose.

24-inch Objective of the Sproul Telescope: J. A. MILLER and R. W. MARIOTT.

The 24-inch objective for the Sproul telescope by the John A. Brashear Co. was completed and mounted in the Sproul Observatory of Swarthmore College in December of 1911. This paper discussed the quality of this objective as determined by the Hartmann method. In February of 1912, extra focal exposures on Capella were made through a screen containing 44 circular holes, 33 mm. in diameter, so arranged as to cover 9 zones of the lens. The exposures were made on Cramer Instantaneous Isochromatic plates. A yellow ray filter made by Wallace in accordance with the color curve of the objective was placed in front of the plate and almost in contact with it. Later a set of extra focal exposures were made on Arcturus in the same way. In the meantime, however, a spring holding the lens in its place in the cell was slightly loosened. The exposures on Arcturus were through a screen containing 78 circular holes of 25 mm. diameter, so arranged that it covered 10 zones. The measure demonstrated that qualitatively the two tests showed slight axial stigmatism, at approximately the same points in the lens. Hartmann's characteristic T for the Arcturus test is 0.270 and for the Capella test, 0.274, showing that the lens is an excellent one.

The Orbits of 44 Eclipsing Binaries: HARLOW SHAPLEY.

Using the methods recently developed by Professor Russell, orbits have been computed for all eclipsing variable stars for which there exists reliable photometric data. Included in the material discussed are unpublished observations made by the writer with the Princeton polarizing photometer of the stars *RZ* Draconis, *RX* Draconis, *RR* Draconis, *WZ* Cygni, *AE* Cygni, *ZZ* Cygni, *RW* Capricorni, *RX* Herculis and *RW* Monocerotis. The periods of a few stars have been redetermined. Secondary minima have been found from an analysis of maximum light observations in the cases of *U* Cephei, *R* Canis Majoris, *RZ* Draconis, *ST* Carinæ, *SU* Centauri and *SZ* Centauri, and possibly for *S* Cancri, δ Libræ and *RW* Monocerotis. The investigation of the light curves of

U Ophiuchi, *RZ* Centauri and *SZ* Centauri shows that the periods of these variables are double the values heretofore given, for in each case two minima of unequal depth alternate. This is also probably true for *SS* Carinæ and for *RX* Draconis.

For more than 80 per cent. of the orbits studied circular elements represent the observations satisfactorily. In no instance has an orbital eccentricity been found to exceed 0.1. The fainter component is very generally the larger of the pair. In only one case out of nine is the dark companion definitely smaller. Pairs of equally luminous stars are rare; equal radii are more common.

The elongations of the component stars through gravitational interaction has affected the shape of the light curves for one third of the number here considered to a degree sufficient to be taken into account in the discussion of the orbits. The square of the eccentricity of a meridian section of the assumed similar prolate spheroids is greater than 0.30 for β Lyræ, *RS* Sculptoris, *RR* Centauri and *V* Puppis; it is greater than 0.20 and less than 0.30 for *U* Pegasi, *U* Scuti and *u* Herculis; and between 0.10 and 0.20 for *U*. Ophiuchi, *V* Serpentis, *RZ* Centauri and *SZ* Centauri. These data have enabled the comparison of the *observed* relation between the prolateness and distance of centers with the *theoretical* relation derived by Darwin for equal masses of homogeneous, incompressible fluid. A remarkable agreement is found.

The densities of the pairs were computed in terms of the sun's density, on the assumption of equally massive components. An important relation is found connecting density and spectral type. The average density of nine stars of Classes *B*1 to *B*8 is 0.16; of 26 stars of Class *A* it is 0.13; but for eight stars of Classes *A*5 to *F* the average is 0.55. No star of the first two groups has a density as great as one half that of the sun; and the solar density is not exceeded by any in the third group.

A general investigation has been made in connection with Professor Russell of the theory of darkening at the limb in eclipsing variables and of the relation existing between orbital elements derived on the assumption of uniformly illuminated disks and of disks darkened to zero at the limb. Tables analogous to those used in deriving elements on the former assumption have been constructed.

On the Graphical Representation of Eclipsing Variables: Henry Norris Russell.

The computed elements of an eclipsing variable are admirably adapted for graphical illustration. A diagram of the system as seen from the earth exhibits at a glance all the geometrical elements. By a proper choice of scale, it may be made to show much more. If we assume that each component is equal in mass to the sun, their mean distance (in solar radii) will be $5.29\ P^{2/3}$, where P is the period in days. If platted on this scale, the radius of the orbit will at once indicate the period, and those of the individual stars their probable densities (on the usual assumption of equality of mass). By suitable shadings, the relative surface brightness may also be indicated, and thus practically all the facts for several systems may be displayed on a single sheet.

Such diagrams also give, in all probability, a very good idea of the actual dimensions of the various systems. No stellar system has yet been reliably investigated whose mass is less than one fourth that of the sun; and masses exceeding sixteen times the sun's are very rare. It follows that the actual dimensions of a given system, compared with the sun, are very unlikely to be more than twice, or less than half, those indicated by diagrams prepared as above. Since most eclipsing variables are too faint for direct spectrographic investigation, this is probably the best way at present available of getting an idea of their real size.

Relation Between Spectrum and Color-index of 500 Stars: J. A. Parkhurst.

The revised data from the writer's forthcoming catalogue of magnitudes and spectra of northern stars[3] furnishes material for a curve showing the relation between spectrum and color-index. The range in magnitude of the stars used is between 4 and 9, the greater number lying between 6 and 8.5. The average magnitude is 7.3 visual, corresponding to 7.7 photographic since the color-index of the average star is 0.4. The Harvard classification is used.

Platting the color-index as abscissæ and the spectral class as ordinates, a straight line is found to fit the points better than any simple curve. The lantern slide accompanying the paper shows a comparison between this "curve" and those published by King in *Harvard Annals*, 59, 180, and Schwarzschild in his Göttingen *Aktinometrie*, *B*, 19. King's stars are mostly brighter than magnitude 4.5, while Schwarzschild's are about the same brightness as those measured by the writer. The present work differs from the other

[3] *Ap. J.*, 36, 169, 1912.

two, in that all elements used were determined by the same person and the same instrument.

The Attraction of Sun-spots for Prominences: FREDERICK SLOCUM.

In the autumn of 1910 a large group of sun-spots passed several times across the face of the sun. On its first passage, from August 2 to August 15, it was given the Greenwich number 6,874.

Active prominences were observed in the immediate vicinity of the spot group from August 2 to November 5, but the best displays occurred on the west limb on October 8, extending from Lat. $+6°$ to $-37°$, and on the east limb on October 22, extending from Lat. $+12°$ to $-36°$. Slides of calcium spectroheliograms of the spot, the surrounding flocculi and the attendant prominences were shown.

The prominences were pouring from both sides apparently right down into the spot. Points that can be identified on two or more plates give velocities along the apparent trajectory up to 110 km. per second, and show a marked acceleration towards the spot. The conclusion is that some sun-spots exert an attraction for the material of which prominences are composed.

No.	Star	π	P. E.	Remarks
1	ϕ Androm.	$+0''.014$	$\pm 0''.017$	Visual binary.
2	48 Cassiop.	-0.001	± 0.015	Visual binary.
3	20 Persei	-0.008	± 0.006	Visual binary.
4	9 Camelop.	$+0.030$	± 0.005	Spectroscopic binary.
5	μ Orionis	$+0.036$	± 0.007	Spectroscopic binary.
6	Groningen VII. 20	$+0.129$	± 0.012	Faint star with large proper motion.
7	*BD* 18°, 3424	$+0.004$	± 0.014	Faint star with large proper motion.
8	17 Lyræ *C*	$+0.128$	± 0.008	Faint star with large proper motion.
9	*P* Cygni	-0.014	± 0.008	Nova?
10	τ Cygni	$+0.001$	± 0.007	Visual and spectroscopic binary
11	Nova Lacertæ	$+0.011$	± 0.013	Nova.

Stellar Parallaxes from Plates made with the Forty-inch Refractor of the Yerkes Observatory: F. SLOCUM and S. A. MITCHELL.

The present parallax program contains about 150 fields, including (*a*) stars with large proper motion, (*b*) stars with large radial velocity, (*c*) binaries, visual and spectroscopic, (*d*) selected stars of the different spectral types, (*e*) novæ, and stars in any way peculiar, (*f*) the Kapteyn zone $+45°$. The following parallaxes have recently been determined:

The average number of plates used for each of the above determinations is eleven, the average number of comparison stars, five, and the average magnitude of the comparison stars, 9.6. Numbers 3, 4, 5, 9 and 10 were measured and reduced by Professor S. A. Mitchell, of Columbia University, and numbers 1, 2, 6, 8, 11 by Professor Slocum, and number 7 by Miss M. M. Hopkins, of Smith College.

The Spectrum of Nova Geminorum No. 2 on March 13, 1912: R. H. CURTISS.

The Detroit Observatory slit spectrograms of Nova Geminorum II. secured on March 13, 1912, show characteristics which have important bearing on the nature of the spectral changes of a nova as it approaches its maximum radiance. The nova's spectrum on this date strongly resembles that of March 15, when the nova maximum type was generally recognized, the peculiarities of the light on the earlier date being strongly accentuated two days later. The conclusion is suggested that the peculiarities of the nova type appeared in the spectrum of this star earlier than has been supposed.

The Plane Grating Spectrograph for Stellar Work: J. S. PLASKETT.

This paper gives a short account of some preliminary tests on the use of a plane grating as the dispersion piece of a stellar spectrograph. The grating with ruled surface 2¼ by 3¾ inches, 15,000 lines to the inch, was specially ruled to give great concentration and it is estimated that 50 per cent. of the incident light is diffracted into the first order on one side. The spectrograph has been tested only in the Littrow form, with a 2½-inch Brashear Triplet of 37½-inch focus, giving a linear dispersion of about 17.5 Å. per mm. at H_γ. It gives beautiful definition and a field very nearly flat over the range used from λ4800 to λ3500. The relative intensity of star spectra obtained with this instrument, and the Ottawa three-prism spectrograph with a camera objective giving the same dispersion at H is as follows: Region λ4700–λ4800, prismatic about twice as intense as diffraction spectrum. Region λ4300–λ4200, spectra of nearly equal intensity. Region λ4150–λ4100, diffraction two to three times as intense

as prismatic spectrum. Region λ4100–λ3850, diffraction spectrum of nearly uniform intensity and nearly as strong as at H_γ. Prismatic spectrum, none. It is evident that with this dispersion the diffraction spectrograph is superior, especially towards the violet and ultraviolet. When it is compared with a single prism spectrograph of lower dispersion the advantage will likely be the other way, but if a spectrum of uniform intensity over a wide range is required, and in the red end, where the prismatic spectrum is unduly compressed, the grating spectrograph will undoubtedly possess many advantages. As soon as possible a more complete test of its performance will be made.

The Cincinnati Astronomical Society: DELISLE STEWART.

This paper describes the organization and activities and plans of the society. The suggestion is made that some definite connection between the national and local societies might be worth consideration.

Radium and the Chromosphere: S. A. MITCHELL.

This paper has been published in *A. N.*, 4600, so only the conclusions need be given here.

At the 1905 eclipse, while a member of the U. S. Naval Observatory expedition in Spain, the writer photographed the "Flash Spectrum" with such dispersion and definition that it permitted the determination of wave-lengths which are in error but a few hundredths of an Ångstrom. A comparison with the radium spectrum showed that a majority of the lines due to radium nearly coincide in the chromosphere with lines already satisfactorily identified from other sources. The third strongest line of radium at λ4826.10, if present in the chromosphere, must be very weak. The comparison between the spectra of radium and of radium emanation and the chromosphere has led me to the conclusion that there are no radium lines in the sun. A similar lack of uranium lines likewise appears.

It will be necessary to obtain photographs of novæ with a much greater dispersion than that used at Bonn before deciding that radium or uranium lines are found in their spectra.

Absorbing Medium in Space: EDWARD S. KING.

The results given in *Harvard Annals*, 59, indicated the presence of an absorbing medium in space. The amount found was 0.0377 mag. for the photographic rays, and 0.0184 mag. for the visual rays, while traversing the unit of distance, which is measured by 32.6 light-years.

These figures having been derived from 26 stars, it was thought best to improve the data by applying the method to other stars. Accordingly, a supplementary list of 22 stars was prepared from the *Publications of the Groningen Laboratory*, No. 24, and observed. The procedure was in all respects precisely that followed previously. The resulting values had the same sign, indicating absorption by greater redness, but were somewhat larger than before. By selecting from both lists only those stars having the parallax most accurately determined, the reduction gave values identical with the above results from *Harvard Annals*, 59. Thus, the indications from this work also point to the presence of an absorbing medium in space, or some factor which produces effects similar to absorption by making the more distant stars appear redder.

Proper Motions of Faint Stars: GEORGE C. COMSTOCK.

The writer, who has been engaged for some years upon a study of the motions of the faintest stars for whose determination adequate material can be found, presents in this paper results relating to more than 250 stars fainter than the tenth magnitude of the Harvard scale. These motions have been derived from micrometer observations by which the positions of the faint stars are referred to neighboring brighter ones of known proper motion, the time interval covered by the measures being in a few cases as small as a quarter century but more frequently extending to fifty or seventy-five years. The probable error of the motion assigned each star in each coordinate has been determined, and from a comparison of these numbers with similar data given in Boss's Preliminary General Catalogue it appears that the proper motions here considered, tenth to thirteenth stellar magnitude, are at least of equal precision with those given for the fainter stars of the Boss Catalogue, 7.5 to 9.0 magnitude. The proper motions here considered are all referred to the Boss system.

In a certain number of cases the motions here investigated are shown to be orbital, the faint star being physically connected with its brighter companion; but when the angular distance separating the stars exceeds the Struve double-star limit of 32″ this connection is found to be very infrequent and in about 80 per cent. of the cases here investigated, *i. e.*, more than 200 stars, the motion of the faint star appears to be uninfluenced by its

brighter companion. Frequency curves showing the distribution of total proper motion and of motion in both right ascension and declination were exhibited and certain suggestions relative to the structure of the stellar system were derived from them; *e. g.*, the mean motion of these stars, about 3″.5 per century, is larger than has usually been supposed, indicating a smaller total extent than is commonly attributed to the sidereal universe. A general southerly drift, shown by these stars, suggests that in great part they lie outside a group associated with the sun and comprising a large part of the brighter stars. The precession constant furnished by these faint stars is shown to be in excellent agreement with that found by Boss from the brighter stars, implying that these bright stars possess, as a whole, no motion of rotation about the earth's axis that is not shared by the fainter stars.

A curious empirical relation, long known but little heeded, is confirmed and considerably extended by these results, viz., the product, stellar magnitude multiplied by proper motion, is approximately constant over all magnitudes from the second to the eleventh, inclusive, and unless there are conditions of the problem not now apparent this relation would imply that in the average of a large number of cases a star's distance from the sun is proportional to its numerical magnitude. This suggestion is probably of too revolutionary character to be readily accepted, although it is paralleled by the conclusion reached by Campbell from spectroscopic evidence that the stars of different magnitudes are more thoroughly intermixed in space than has been commonly assumed.

The Solar Eclipse of April 16, 1912, as Predicted and as Observed: ARTHUR NEWTON.

The Nautical Almanac Office is preparing for the press the final installment of Professor Simon Newcomb's "Researches on the Motion of the Moon." Corrections therein given have been applied in the American Ephemeris and Nautical Almanac for 1912 to the moon's position in the computation of the two solar eclipses of the present year.

The many observations made on April 17 are entirely confirmatory of the accuracy of these final values by Professor Newcomb. The American Almanac gave a predicted time of occurrence that was within two seconds of the mean observed time. The European almanacs were in error from 15 to 30 seconds. The central line of eclipse was placed about one mile too far to the northwest by the American Almanac, and much farther in the same direction by the other almanacs, with the exception of the French.

These results indicate that the moon's position as employed in the American Ephemeris for this eclipse required a further correction of $+1''.0$ to the longitude and of $-0''.5$ to the latitude. The prediction was further borne out in the phase which was total in Portugal and Spain with a maximum duration of one second, and annular in France with a duration of three or four seconds at Paris. The indicated correction to the adopted semi-diameter of the moon is less than $0''.2$.

A Method of Approximating Rainfall over Long Periods and Some Results of its Application: A. E. DOUGLASS.

It was found by a test extending over 43 years that the radial thickness of the rings of the yellow pine of northern Arizona gives a measure of the rainfall in that vicinity with an average accuracy of over 70 per cent. By applying a simple formula, taking into account the conservation of moisture, the accuracy may be increased to about 75 per cent. By cross identification of rings between all the hundred trees examined, the accuracy of counting rings was greatly increased.

Five trees from the vicinity of Flagstaff were measured to the number of 400 rings, and two of these to 500. It was found that all the trees in that locality gave very similar records. A 21-year variation amounting in all to 20 per cent. of the mean is shown in 400 out of the 500 years recorded. A shorter variation amounting to 16 per cent. of the mean was found to have a period of 11.4 years. Its plot derived from 492 years shows 2 maxima which correspond in time with 2 maxima of rainfall in the 50 years of records on the southern California coast. These in turn match the major and minor maxima in the temperature of that region for the same period. The larger maximum of the latter occurs at the time of the sun-spot minimum as averaged for 125 years.

The Algol Variable RR Draconis: F. H. SEARES.

The writer made an attempt to determine the light curve of this star from observations with the 7½-inch refractor of the Laws Observatory. On account of its faintness it could not be followed through the minimum. On August 7 the star was followed photographically through an eclipse with the 60-inch reflector of the Mt. Wilson Observatory. Sixty-five exposures, covering an interval of 6 hours, were obtained. The variable is normally of 9.70 mag. There is an interval of

constant minimum brightness, lasting about 1½ hours, during which the magnitude is 13.50. The duration of eclipse is 8½ hours. The light change is very rapid, the last magnitude of the descent is accomplished in 20 minutes. For two magnitudes of the descent the visual and photographic curves are in close agreement, but from this point the photographic variation seems more rapid than the visual. For $\Delta m = 3.25$ mags. visually, the photographic value is 3.50. This greater photographic range is probably real. The observed time of minimum was eleven minutes late of the ephemeris from the elements of the Laws Observatory Bulletin No. 9, indicating a correction to the period, which is slightly less than $2^d\ 20^h$, of less than a second.

Spectrographic Observations of ϕ Persei: FRANK C. JORDAN.

This star has been known, since 1889, to have a bright line spectrum. About 400 spectrum plates have been obtained by various observers, and its period determined as 126.5 days. The hydrogen lines are constituted as follows: A broad, weak, underlying absorption, upon which is superposed a broad emission line appearing as two because of a central narrow and strong absorption. The sharpness and strength of the absorption lines varies strikingly in different parts of the orbit, becoming at one phase so weak and diffuse as to be almost immeasurable. Helium lines show only at certain phases. There are visible at least twelve other bright lines which seem to be constituted like the hydrogen lines, and to give the same velocity as these lines.

The velocity curve is peculiar in that at about one third of the period from maximum positive velocity there is a decided hump. The highest velocity is + 44 km. It goes down to — 7 km. at phase 24 days, up to 0 km. at phase 35 days, then down to a minimum of — 21 km. at phase 75 days. In different revolutions of the system the velocity curves do not seem to be the same either in shape or amplitude.

Preliminary measures on the bright hydrogen lines give a velocity curve different from that of the absorption lines, but not such a curve as would be given by a secondary body.

Spectrographic Observations of Algol: FRANK SCHLESINGER.

Algol has been upon the observing list for the Mellon spectrograph during the past six years. A total of 336 spectrograms have been secured, and have been measured and reduced by the author under as uniform conditions as possible. A study of this material yields the following chief results: (1) The long period oscillation in the radial velocities, announced by Belopolsky in 1906, is unmistakably confirmed. This oscillation has a period of 1.874 years and a semi-amplitude of 9.14 km., and is in an orbit whose eccentricity is small. (2) Such an oscillation should be accompanied by a similar oscillation in the times of light minimum, the latter sometimes occurring as much as 5 minutes in advance and sometimes 5 minutes after the predicted epochs. An examination of the rich photometric material on this star obtained in the years from 1852 to 1887 brings out this small term with almost precisely the amplitude computed from the spectrographic measures. (3) The eccentricity of the short-period orbit (2.87 days) comes out small, very probably less than 0.02. This seems to make it necessary to reject Tisserand's explanation for Chandler's long-period term (141 years) in the times at which light minima occur, since this explanation demands an eccentricity in the neighborhood of 0.13. A renewal of photometric observations of Algol is much to be desired, as well as a rediscussion of all the available data of this kind.

The Orbit of λ Tauri: FRANK SCHLESINGER.

Eighty-nine spectrograms of this bright Algol variable have been secured with the Mellon spectrograph at the Allegheny Observatory. These yield the following elements of its orbit: period (assumed from photometric data), 3.9529 days; semi-amplitude 58.1 km. ± 1.08 km.; eccentricity, 0.053 ± 0.017; longitude of periastron, 111°.6 ± 20°.5; time of periastron passage, 0.31 days after light minimum ± 0.23 days; mean velocity, + 13.6 km.

The lines in the spectrum of this star are affected by shadings alternately on their red and violet sides. These can not be due to the presence of the fainter spectrum, since they are too close to the lines of the bright spectrum to permit of this explanation. The spectrograms are all upon plates of fine grain.

The Magnitude Scale of the Polar Sequence: F. H. SEARES.

The methods of photographic photometry employed with the 60-inch reflector of the Mt. Wilson Observatory involve the use of a wire gauze screen and diaphragms of various apertures. The most troublesome difficulty has been the determination of the error depending on the distance of the stars from the axis of the instrument which varied

from plate to plate and with direction on the same plate. The erratic variations seem now to be eliminated. At present, the point of greatest interest in photographic photometry relates to the determination of an absolute scale. The first determination of magnitudes has been for stars of the polar sequence. Fifteen plates with the wire gauze screen and diaphragms of 32 and 14 inches, affording 27 separate determinations of the scale, have been used. The exposures range from 1 to 11 minutes, the magnitudes from 8.8 to 17.6, although the limits for reliable results are 10.5 to 15.5. The mean deviations of groups of stars from results obtained at the Harvard Observatory are as follows:

Magnitude	Mt. W.-H.	No. Stars
8.81	+ 0.11	1
10.5 — 11.5	— 0.03	6
11.5 — 12.5	— 0.02	4
12.5 — 13.5	+ 0.03	6
13.5 — 14.5	+ 0.03	5
14.5 — 15.5	— 0.01	5
15.5 — 16.5	— 0.13	4
16.5 — 17.5	— 0.27	7

The zero point of the Mt. Wilson scale is such that the sum of the deviations from the Harvard scale between 10.5 and 15.5 is zero. The cause for the divergence beyond mag. 15.5 is not yet established, but may be settled by comparing the scale here given with that derived from plates of longer exposure.

Variable Asteroids: S. I. BAILEY.

In connection with the photometric measurements of Eros, made at Arequipa in the years 1902 and 1903, observations of Ceres, Parthenope, Massalia, Kalliope, Urania, Harmonia, Melete, Hecuba, Sirona, Baucis, Celuta, Chryseis, Kallisto, Kleopatra, Germania, Bamberga, Tercidina, Melusina, Ilmator, Aquitania, Aurelia, Eros and Tergeste, were undertaken especially for the detection of new cases of variability in light. The Rumford photometer was used with the 13-inch Boyden telescope. Five cases of variability, in addition to Eros, were detected: Urania (30); indications of variability, no satisfactory period found. Hecuba (108); indications of a small range of variation, having a period which appears to be a sub-multiple of $0^d.99$, perhaps $0^d.330$. Sirona (116); indication of range of half a magnitude with period $0^d.403$. Celuta (186); variation small, if real, period $0^d.364$ satisfies all observations. Tercidina (345); small variation, satisfied with period $0^d.366$.

The light curves of Eros independently determined by the Rumford photometer and by photographs made with the Bruce telescope agree closely, but those obtained with the photographs have the smaller accidental errors. The photographic method offers many advantages. In order that photographs shall serve for the accurate determination of magnitudes, it is very desirable that the images of the asteroids shall be comparable with those of the stars. This can be accomplished by giving to the plate, while the telescope is moving at sidereal rate, a motion equal to one half the apparent motion of the asteroid.

Results of Latitude Observations at the Flower Observatory from December, 1904, to July, 1911: C. L. DOOLITTLE.

The series here considered consists of 13,852 determinations of latitude made with the zenith telescope, and 11,591 with the Wharton reflex zenith tube. All of the observations were made by myself and the two series are practically simultaneous. A comparison of the results given by the two instruments furnishes data, to be found nowhere else, so far as I know, for examining the daily fluctuations to be found in all extended series of this character.

For this purpose we have 1,540 comparisons. We find 149 cases where the residuals from both series are at least twice the probable error. Of these, 79 have like signs and 50 unlike. There are 12 cases where both residuals are at least three times the probable error; 10 of these have like signs. In these cases the residuals are four times the probable error and in one case six times the probable error. All of these have like signs.

It is obvious that we have to do with a class of errors other than those due to observations, and that before much greater progress can be hoped for in this direction, means must be found for this elimination.[2]

The Constant of Aberration: C. L. DOOLITTLE.

From the observations carried on at the Sayre and Flower Observatories from December 1, 1889, to June 8, 1911, with the zenith telescope and the reflex zenith tube there have been derived 22 values of this constant. Although these range in value from 20″.448 to 20″.605, the computed value of the probable error in no case differs very much from 0″.01. If we give all equal weight we have

[2] See *A. J.*, 641.

for the arithmetical mean of all, 20″.526 ± 0″.0057. There are, however, very good reasons for assigning higher weights to some of the 22 values than to others. The results have been derived from observations at two different places with practically four different instruments. We find, however, for the weighted means practically the same value as that given above, 20″.525 ± 0″.0045. The corresponding value of the solar parallax is 8″.780.[4]

A Test of the 18½-inch Objective of the Dearborn Observatory Telescope: PHILIP FOX.

It has been interesting to apply Hartmann's test to this objective, the high quality of which is established by the long series of difficult double-stars which have been discovered with its aid by both Burnham and Hough. The perforated screen contained 96 holes, 12 mm. in diameter, arranged on 24 zones. The resulting curve of zonal foci is very smooth. The extreme range in focal length for the different zones is about 2 mm. The mean of the two sets gives for the Hartmann criterion T, the result $T = 0.30$.

Some Results from the Personal Equation Apparatus of the 9-inch Transit Circle of the U. S. Naval Observatory: W. S. EICHELBERGER and F. B. LITTELL.

With a personal equation apparatus the following results were obtained for the three observers, L, M, P, positive corrections indicating that the observer anticipates.

CHRONOGRAPHIC OBSERVATIONS

δ	Sec δ	L RL	L LR	M RL	M LR	P RL	P LR
		s	s	s	s	s	s
0°	1.0	−0.132	....	−0.038	....	−0.060	....
39	1.3	−0.131	−0 136	−0.028	−0 088	−0 077	−0.100
62	2.1	−0.180	−0.167	−0.018	−0.045	−0 057	−0.112
82	7.4	−0.120	−0 188	−0.088	−0.058	−0 129	−0.158
85.1	11.7	−0.115	−0.203	−0.021	−0.037	−0.062	−0.112

EYE AND EAR OBSERVATIONS

δ	Sec δ	L RL	L LR	M RL	M LR	P RL	P LR
85.1	11.7	+0.29	+0.28	+0.02	+0.05	+0.18	+0.23
87.7	24.9	+0.39	+0.29	−0.04	+0.18	+0.25	+0.27
88.9	52.1	+0.78	+0.64	+0.15	+0.26	+0.56	+0.68

Assuming that the personal equation can be represented by $p + m$ sec $\delta \pm n$ sec δ, the coefficients were computed and corrections applied, thus reducing the errors to a very small quantity, generally less than $0^s.01$ for chronographic, and less than $0^s.05$ for eye and ear observations.

[4] See *A. J.*, 639, and Pub. Flower Observatory, Vol. III., 2.

Comparisons were made to test the reliability of these results, with satisfactory consequence.

A High-level Measurement of Solar Radiation: FRANK W. VERY.

Applying the methods elaborated in a previous paper, "The Violle Actinometer as an Instrument of Precision,"[5] to the reduction of an observation by M. Violle, who obtained from a sounding-balloon record at an altitude of 13,700 m. an excess of 53° in sunshine above an air temperature of 65° below zero Centigrade, the author obtained for the observed solar radiation-equivalent at 13,700 m., 2.86 gram cal./sq. cm. min. Making allowance for the absorbent atmosphere, deriving the value from the consideration of observations at sea-level, Keeler's and Nanry's on Mt. Whitney, Violle's on Mt. Blanc, the value of the solar constant obtained is 3.5 gram cal./sq. cm. min.

A Criterion of Accuracy in Measurements of Atmospheric Transmission of Solar Radiation: F. W. VERY.

The coefficient of atmospheric transmission of solar radiation on a given day is variable because of the variation of atmospheric extinction with zenith distance, and because this absorbent quality changes in the middle of the day, especially if much moisture is present. Thus in Bouguer's formula,

$$R = Ap^{\epsilon},$$

there are two variables p and ϵ, and the equation is soluble only by approximation.

To accomplish this approximation, M. Crova has proposed that the curve of radiation shall be considered as the envelope of a series of logarithmic arcs. By constructing successive subtangents to this envelope at points having values of ϵ for abscissæ, coefficients of transmission of the sifted rays, at stages corresponding to determined values of ϵ, can be found by the equation

$$T = e^{-\frac{1}{m(1+\epsilon)}},$$

where

$$m = \log\left(\frac{1+\epsilon_1}{1+\epsilon_2}\right) + \log\left(\frac{R_2}{R_1}\right).$$

This procedure usually gives a series of varying values of m, so that a solution of the problem is no nearer, unless some occasion can be found when m does not vary appreciably. Such an extraordinary occasion is on record in the observation by Savélief at Kief, Russia, December 28,

[5] *Pub. A. A. S. A.*, 2, 90.

1890, which may be used as a test by which less perfect measurements may be judged. By theory, we have the criterion that $1/m$ must always be a fraction. Rejecting all observations which do not conform to this criterion, also midday observations which are affected by the usual midday depression, the author compares the mean of the two series of observations by Kimball with Savélief's measures. The mean values are:

$$\epsilon = 7,\ \text{Savélief}\ 1/m = 0.647,$$
$$\text{Kimball}\ 1/m = 0.786;$$
$$A = (1 + 7)^{0.647} \times 0.94 = 3.606\ \text{(Savélief)};$$
$$A = (1 + 7)^{0.786} \times 0.72 = 3.698\ \text{(Kimball)}.$$

Application of the criterion brings these otherwise discordant observations into agreement.

Sky Radiation and the Isothermal Layer: F. W. VERY.

The author describes the mechanism of heat transference and radiation absorption in the atmosphere, referring to his work on "Atmospheric Radiation," pp. 114–115 and 124. Vapors are found in the atmosphere just so long as there remains a quantity of even the least absorbing gases sufficient to preserve the temperature above the vaporization point. It was pointed out in discussing the absorbing power of gases and vapors that the absorbing power of some gases was so feeble that many miles of absorbing layers were necessary to show the spectrum lines, while other lines, notably those of water vapor, are produced by the substances in very attenuated form. Water vapor is found at the altitude of 30 km., and since temperature inversion in the atmosphere is found everywhere associated with excessive amounts of aqueous vapor, there is no reason to doubt that the great region of permanent temperature inversion, the "isothermal layer," is due to this substance. The extreme tenuity of the vapor offers no difficulty to this supposition, since the layer is many kilometers deep. I have found the great Xi bands of aqueous vapor producing almost complete extinction of the solar spectrum through a range of 3 microns, when the temperature was — 30° C. This temperature is sometimes exceeded even in the isothermal layer, where also a relative humidity as high as 50 per cent. has been observed.

There are three principal loci of terrestrial radiation, namely: (1) a thin, heated, superficial layer of the terraqueous globe; (2) the solid or liquid particles suspended in the air; and (3) the upper static layer of air, called the isothermal layer, in which the permanent temperature-inversion resides. The author's supposition that elevated regions of the atmospheric, up to something like 20 km., undergo much larger temperature-variations than the more deeply situated layers of the free air, has been confirmed by Blair's observations. This phenomenon also is attributed principally to absorption by aqueous vapors.

The earth's effective temperature is not that of an elevated layer of cool air, shown on the records of the meteorological stations, but a mean in varying proportions of the three loci named, which owe their temperature to a complex of radiation, convection, absorption, cloud, precipitation, etc.

The general conclusion from sky measurements is that the effective sky-temperature is lower, on the whole, when the dew-point is lower, and the aqueous obstruction of radiation to space is least; but even in the coldest and driest weather, the sky temperature has never been found lower than that of the isothermal layer, which behaves like a nearly black body of approximate temperature, $T = 218°$ Abs. C., λ max $= 13.5\,\mu$, and is opaque to most of the radiation from the solid earth of greater wave-length than this maximum.

Orbits of the Visual and Spectroscopic Binary Star Epsilon Hydræ AB: R. G. AITKEN.

The close double star known as ϵ Hydræ *AB*, discovered by Schiaparelli in 1888, is unique among the visual binary systems in that the elements of its orbit can also be deduced from the spectrographic measures of the radial velocity.

A revised system of elements from the micrometer measures, which now cover an arc of 450°, gives 15.3 years as the best value for the revolution period. Adopting this as correct, the remaining elements were computed independently from the radial velocity measures, which extend from 1899 to 1911 and include both maximum and minimum values. It was possible to find a set of elements which would satisfy both series of observations within the error of observation. These elements are: $P = 15.3$ years $= 5{,}588$ days; $T = 1900.97 =$ J.D., 2,415,375; $e = 0.65$; $\omega = 90°.0$; $i = -49°.95$; $\Omega = 104°.4$; $a = 0''.23$; $a \sin i = 493{,}000{,}000$ km.; $v = +36.78$ km.; $K = 8.45$.

From these elements we find the mean distance between the two components of ϵ Hydræ to be 1,359,000,000 km., or 9.1 astronomical units, the parallax of the system, 0″.025 and its mass, 3.33 times the sun's mass. Seeliger has shown that the periodic variations in the micrometer measures connecting the third star *C* with the close pair

can be accounted for by the orbital motion of the binary. Assuming the effective light center of AB to be one seventh of the distance from A toward B, he determines the mass ratio of the binary to be $m'/m = 0.9$.

Within the next five years the radial velocity will again reach both maximum and minimum values, and spectrographic observation during this interval will be of the greatest value in determining the orbit elements more precisely.

International Standards of Wave-lengths: C. E. St. John and L. W. Ware.

This paper, which has appeared in full in the Contributions from the Mount Wilson Solar Observatory, No. 61, gives the results of the measurements of two series of plates of the iron arc spectrum, obtained with two plane grating spectrographs, one on Mt. Wilson and one in Pasadena. The precision obtained by interpolation between the international standards of the second order is 0.001 Ångstrom in the case of good lines. No errors were found in the relative wave-lengths of the secondary standards between λ5371 and λ6494 greater than 0.001 Ångstrom except for the line λ5434, where it is 0.002 Å. In this region 44 lines were found unsuitable for standards of wave-lengths on account of pressure displacements accompanied with dissymmetry. Several lines showed differences in wave-length between the two series, bearing relation to the quality of line under pressure as shown on the plates of Gale and Adams.

The Solar Rotation: J. S. Plaskett.

This paper presents the general results of a determination of the solar rotation for 1911 and a preliminary result for 1912. The values obtained at Ottawa for 1911 are well represented by the formulæ

$$v = (1.483 + 0.532 \cos^2 \phi) \cos \phi,$$
$$\xi = 10°.32 + 4°.05 \cos \phi,$$

where v is the sidereal linear velocity of the reversing layer in km. per sec., and ξ the daily sidereal angular velocity, ϕ the solar latitude. These are in remarkably good agreement with Duner's and Adams's 1908 values, except for a small angular difference constant for all latitudes. The formulæ probably represent very closely the law of variation with latitude. Measures of the same plates by different observers give systematic differences of two or three per cent., indicating that the differences noted above are probably personal, and due to the character of the lines. The discussion of some 3,000 residuals from different lines and elements show no systematic differences of velocity for different elements, or for different lines of the same element. No change greater than one per cent. is revealed in results for 1911 and 1912.

The Spectroscopic System 9 Camelopardalis: O. J. Lee.

This star was announced as a binary by Frost and Adams[6] from measures of the broad lines. They also found that the H and K lines, strong and narrow, give a variation which differs in phase and amplitude from that given by the other lines.

The observations cover about 3,000 days. The form of the velocity curve is incompatible with a simple two-body system and hence a certain form of calcium envelope has been assumed which both assists in reproducing the observed velocity curve and accounts for the difference in character of the broad lines and the calcium lines in the spectrum. The observed velocity curve is composed of three elements: the orbital velocity of the primary, the velocity of the calcium envelope about the center of the primary regarded as a stationary point, and the periodic eclipse of the spectroscopically effective parts of the envelope by the primary.

The elements of the stellar orbit are: $P =$ 7.9957 days, $e = 0.30$, $\mu = 45°.024$, $K = 9.0$, $\omega =$ 90° or 270° closely, $T =$ J.D. 2,416,480.85, $\gamma =$ -2.25 km., $i = 90°$ nearly.

Assuming that the effective calcium clouds center about the two zero velocity points, which lie one on each side of the primary $M/m = 2.85$ and $M + m = 0.0023$.

The Rotation of Jupiter's First Satellite: A. E. Douglass.

This satellite appears elliptical in form. A number of persons unacquainted with the identity of the satellites have been asked to select the one appearing elliptical. In fourteen out of seventeen trials the first has been picked out. The ellipticity is not constant, but varies on a period which does not seem to be constant. A hypothesis to account for the phenomena supposes the satellite to be an irregular body resembling an ellipsoid of three unequal axes in which the axis of figure has a considerable angle to the axis of rotation.

The Light-curve of SS Cygni from the Amherst Observations: D. P. Todd and C. J. Hudson.

Observations of this star and about 50 other

[6] *Ap. J.*, **19**, 350, 1904.

faint variables have, for the past two years, been regularly maintained with the 18-inch Clark refractor of the Amherst College Observatory. The observations are visual estimates and are accurate to tenth-magnitudes. They were much facilitated by the use of an external iris diaphragm, enabling the use of all apertures from 3 to 18 inches. The remarkable fluctuations of this star are represented on a diagram prepared by Mr. Hudson.

Reports of Committees

Professor Campbell sent a written report from the Committee on Cooperation in the Measurement of Radial Velocities. The response of all the members of the committee was to the effect that though they might wish to cooperate, their instrumental resources were too weak to attack a long list of stars below the 5.0 visual magnitude where cooperation is desirable, and further, that fields of greatest usefulness for them consisted in the study of spectroscopic binaries or special groups of stars. In short, cooperation in the determination of radial velocities of extensive lists of stars fainter than the 5.0 mag. is at present impractical. The report ended with some hopeful suggestions.

The report of the Committee on Asteroids, sent by the chairman, Professor E. W. Brown, stated that the principal problems of those interested in the asteroids is to gather data for future discussion, the orbits, the light variations, etc. The first problem is the collection of the observations of position. Some organization to secure more nearly uniform observation of the many asteroids, to care for the new ones, to make certain the securing of a requisite number of early observations, to furnish an early orbit, should be perfected. An international conference on the asteroid problem is desirable.

The Committee on Comets, Professor G. C. Comstock, chairman, reported that the work of collecting data of photographic observations of Halley's comet was practically complete. The catalogue is ready for publication. The committees proposes to publish this together with the photographs secured by Mr. Ellerman at Honolulu.

Professor Schlesinger presented the report of the Committee on Photographic Astrometry. The 10-inch photographic telescope described in the last report has been mounted and put in operation. It is mounted in a constant temperature room having access to the polar region through a window of optically plane parallel glass. Exposures made from without and automatically timed on the chronograph give very exact data for determining the polar point. The methods developed for measuring and reducing the plates were described and some numerical results presented. This work will be continued at least until the spring of 1913, by which time it is expected that definite knowledge will be secured concerning the movement of the pier mounted in this way.

The financial report showed an indebtedness of about $200. Dr. John A. Brashear announced the purpose of certain Pittsburgh friends of the society to clear this indebtedness. This unprecedented generosity was gratefully acknowledged.

The report of the Committee on Teaching of Elementary Astronomy is of more general interest, so it is given in full.

Report of Committee on Cooperation in Improvement of Teaching Elementary Astronomy: C. L. Doolittle, chairman. Report prepared by Miss Sarah F. Whiting.

Your committee was authorized at the Ottawa meeting to send out a circular to the observatories and colleges asking certain questions in reference to the teaching of elementary astronomy, and requesting suggestions as to methods of increasing the numbers in elementary courses, and improving the teaching.

A circular was sent out with the following preamble, to show the intent of the society:

"The Astronomical and Astrophysical Society of America states in its constitution that its purpose is the 'advancement of astronomy.'

"At its late meeting in Ottawa, Canada, it was mindful of the fact that the advancement of science depends not only on the discovery of new truth, but on the diffusion of knowledge, and the scientific spirit which creates a friendly atmosphere for its reception. The society considered the deplorable ignorance of persons, otherwise intelligent, in regard to the every-day phenomena of the sky, and the fact that astronomy lags behind the other sciences in adopting the modern method of laboratory work by the student."

Questions followed in reference to the beginning courses and methods of teaching.

Eighty replies were received, which may be considered representative, since twenty were from state universities, thirty from other universities and colleges of first rank, and thirty-two from smaller colleges and schools. Only ten reported a beginning course in astronomy extending through the academic year; thirteen reported two terms or a semester's work, and the other forty-two only

short lecture courses. Only thirty reported a regular program of evening observations, twelve some daytime exercises, ten some review of the elements of spectrum analysis as a basis for study of stellar classification, fourteen gave some library work, the rest gave only lectures with no laboratory work by the student. But two institutions, Harvard and Wellesley, reported two hours of daytime laboratory work by the students as in other sciences, and this in addition to evening work.

The numbers in the colleges electing an elementary course would be more significant if they could be reported in percentages, but this was not possible. That only eight universities and colleges reported a hundred and more in the first-year classes, three, 70–100, six, 50–70, and sixty-five mostly less than twenty-five, shows that a very small proportion of college men and women know much about anything off this little planet.

Special interest in the movement was emphatically expressed in more than half the replies, and the hope that the society can in some way bring its influence to bear to secure greater place for elementary astronomy in the programs of study, better methods of teaching elementary classes, and aid the teachers to secure better equipment and adequate assistance.

The leaders of the great research observatories, Harvard, Lick, Yerkes, Mt. Wilson, all expressed sympathy in the objects of the committee and the hope that astronomy would not long lag behind other sciences, taken up in liberal education. Several called attention to the fact that teachers of elementary astronomy should be trained as teachers of physics are trained. Colleges should be urged to understand that an observatory for the training of experts is not the entire equipment necessary for the work of a department of astronomy. Some replies, however, state the issue clearly from the standpoint of the heads of the departments of astronomy. In the choice between using the observatory for instruction or for research, the research problems have the stronger claims. As in other cases, the professor should be provided with adequate assistance.

The committee has brought the facts before the Society and calls for the assistance of the Society in constructive plans. The committee has no plan as yet formulated, but requests that it be continued.

Philip Fox,
Secretary

SOCIETIES AND ACADEMIES

THE NEW ORLEANS ACADEMY OF SCIENCE

On Tuesday, November 12, there was held at the Public Library the first regular meeting of the newly reorganized New Orleans Academy of Science. The New Orleans Academy of Science was founded in the year 1853, and was a vigorous society until the war, when its activities were suspended. It was revived again for a brief period soon after the war and then again in 1885, when it met regularly for about five years and published several volumes of transactions. Since 1890 the academy has been dormant.

As now reorganized it consists of sixteen sections with chairmen for each section as follows:

Biology and Physiology, Gustav Mann.
Botany and Bacteriology, C. W. Duval.
Zoology, George E. Beyer.
Anthropology and Ethnology, R. B. Bean.
Philology, Robert Sharp.
History and Biography, Pierce Butler.
Education, J. M. Gwinn.
Economics and Sociology, A. P. Howard.
Chemistry, Miss Ann Hero.
Geology and Mineralogy, B. V. B. Dixon.
Astronomy and Mathematics, A. B. Dinwiddie.
Geography and Meteorology, J. A. Lyon.
Engineering, W. H. P. Creighton.
Physics, H. Clo.
Philosophy, W. B. Smith.

The officers of the newly organized academy are:

President—William Benjamin Smith, professor of philosophy, Tulane University of Louisiana.

First Vice-president—Dr. Max Heller.

Second Vice-president—Dr. Isadore Dyer, dean of the medical department, Tulane University of Louisiana.

Treasurer—Dr. A. L. Metz, professor of chemistry, Tulane University of Louisiana.

Secretary—R. S. Cocks, professor of botany, Tulane University of Louisiana.

Librarian and Curator—Dr. Creighton Wellman, professor of tropical medicine and hygiene, including preventive medicine, Tulane University of Louisiana.

At the inauguration meeting there were addresses by the president and the two vice-presidents. The academy will meet hereafter the second Tuesday of each month.

R. S. Cocks,
Secretary

SCIENCE

FRIDAY, JANUARY 10, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE CLEVELAND MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE sixty-fourth meeting of the American Association for the Advancement of Science was held at Cleveland, Ohio, from December 30, 1912, to January 4, 1913, under the presidency of Dr. Edward Charles Pickering, director of the Astronomical Observatory of Harvard College, Cambridge, Mass.

The excellent arrangements made for the meetings, the good hotel and other public utilities of Cleveland, and unusually mild and pleasant weather through most of the week, combined to make the material environment one of the most agreeable experienced by the association. The number of members registered was 720, and in addition 150 from the affiliated societies; but as is well known this registration is always incomplete, especially in the case of members of affiliated societies who are not members of the American Association for the Advancement of Science. It is safe to say that the total in attendance must have exceeded 1,000.

The following societies, most of them affiliated with the American Association for the Advancement of Science, met in Cleveland at the same time:

Astronomical and Astrophysical Society of America,
American Mathematical Society,
American Physical Society,
American Society of Zoologists, Eastern and Central Branches,
American Association of Economic Entomologists,
Entomological Society of America,
American Nature Study Society,
School Garden Association of America,
American Microscopical Society,
Botanical Society of America,
American Phytopathological Society,
Botanists of the Central States,
Society for Horticultural Science,
American Association of Official Horticultural Inspectors,
Association of Official Seed Analysts,
American Psychological Association,
American Society of Biological Chemists,
American Society for Pharmacology and Experimental Therapeutics,
American Association of Anatomists,
American Physiological Society,
American Federation of Teachers of the Mathematical and Natural Sciences,
Society of the Sigma Xi,
American Society of Naturalists.

The opening general session held on the evening of Monday, December 30, in the ball room of the Hotel Statler was called to order by the retiring president, Dr. Chas. E. Bessey, who introduced the president-elect, Dr. Edward C. Pickering. Addresses of welcome were given by Mr. Newton D. Baker, mayor of Cleveland, Dr. Chas. F. Thwing, president of the Western Reserve University, and Dr. F. M. Comstock, acting president of the Case School of Applied Science. Responses were made by President Pickering. The address of Mayor Baker was especially noteworthy as embodying ideals for the future of Cleveland which aroused the heartiest appreciation in the minds of all his hearers. Perhaps the strongest assurance that Cleveland will ultimately reach the eminent position predicted by him is the fact that it already has the foresight to elect such men to its highest offices. The annual address was then delivered by the retiring president of the association, Dr. Charles Edward Bessey on "Some of the Next Steps in Botanical Science." It is printed in the issue of SCIENCE for January 3. The general session then adjourned and was followed by a reception to the members of the association and affiliated societies.

The annual addresses by retiring vice-presidents were made as follows:

Monday Afternoon

Vice-president Shimek, before the Section of Geology and Geography. Title: "Significance of the Pleistocene Mollusks."

Tuesday Afternoon

Vice-president Frost, before the Section of Mathematics and Astronomy. Title: "The Spectroscopic Determination of Stellar Velocities, Considered Practically."

Vice-president Nachtrieb, before the Section of Zoology. Title: "Section F—Is It Worth While?"

Vice-president Newcombe, before the Section of Botany. Title: "The Scope of State Natural History Surveys."

Vice-president Millikan, before the Section of Physics. Title: "Unitary Theories in Physics."

Wednesday Afternoon

Vice-president Porter, before the Section of Physiology and Experimental Medicine. Title: "On the Function of Individual Cells in Nerve Centers."

Vice-president Thorndike, before the Section of Education. Title: "Educational Diagnosis."

Vice-president Ladd, before the Section of Anthropology and Psychology. Title: "The Study of Man."

Thursday Afternoon

Vice-president Norton, before the Section of Social and Economic Science. Title: "Comparative Measurements of the Changing Cost of Living."

Other addresses worthy of especial note were the following:

On Tuesday evening, Dr. W. J. Humphreys, of the U. S. Weather Bureau, gave an illustrated lecture, complimentary to the members of the American Association for the Advancement of Science and the affiliated societies and to the residents of Cleveland and vicinity, on the subject of "Across the United States with the European Geographers."

On Monday afternoon, President Benjamin M. Davis, of the American Nature Study Society, gave an address entitled "A Summary of the Study of Agricultural Instruction in Rural Schools."

President A. B. Macallum, of the American Society of Biological Chemists, gave an address on Monday on "The Energy of Muscular Contraction; Thermodynamic or Chemodynamic."

Dr. Edward Lee Thorndike gave his address on Tuesday, as president of the American Psychological Association, on the subject of "Ideo-motor Action."

President W. T. Macoun, of the Society for Horticultural Science, also gave his address on Tuesday on the subject "The Relation of Climate to Horticulture."

On Wednesday evening, Dr. Philip P. Calvert, of the Entomological Society of America, gave a public address on the subject "An Entomologist in Costa Rica."

On Wednesday, President W. D. Hunter, of the Society of Economic Entomologists, gave an address on the subject "Insects and Human Diseases."

On Wednesday afternoon, President John A. Lomax, of the Folk-Lore Society, gave an address on "Stories of an African Prince."

On Wednesday evening, Professor W. D. Farlow gave the address of the retiring president on "A Comparison of the Present Conditions in Botany with those in the Early Seventies."

On Thursday evening, Dr. T. J. Headlee gave his annual address, as president of the American Association of Official Horticultural Inspectors, on the subject of "The Federal Plant Quarantine Law."

On Thursday evening, Professor Edwin G. Conklin gave the annual address as president of the American Society of Naturalists on "Heredity and Responsibility."

A number of symposiums and sessions devoted to matters of public interest were held by various sections and affiliated societies. Among these may be mentioned a symposium under the auspices of the American Society of Biological Chemists on "Some Recent Applications of Physical Chemistry in Biology."

A symposium under the auspices of the Botanical Society of America on "Permeability and Osmotic Pressure."

A symposium by the Phytopathological Society on "International Phytopathological Problems."

A symposium in charge of the American Society of Naturalists on "Adaptation."

The section on social and economic science held a symposium on some economic problems of current interest.

A general interest program on sound and sound waves was held under the auspices of Section B.

A general interest program devoted largely to broad educational problems, including a discussion of the National University was held under the auspices of Section L.

The council met daily. Among the chief matters of business transacted were the following:

Seventy-five new members were elected.

Two hundred and fifty-five members were elected fellows.

A report from the committee on policy was adopted, providing for the appointment of a committee of five to consider the future of Section C.

The amendment to the constitution, proposed last year, and providing for the establishment of "Section M. Agriculture," was adopted.

Amendments to the constitution were also proposed as follows, in order that they may be acted upon next year under the provisions of the constitution.

Article 22—Amend by omitting "*Mechanical and*" after the title "*D,*" so as to read; "*D—Engineering.*"

Article 22—After "Section M. Agriculture" add "*The council shall have power to create additional sections from time to time, and to discontinue, combine, or rearrange existing sections.*"

The financial report of the permanent secretary was read, accepted and ordered printed.

The council adopted the following resolutions, relating to the proposed meeting at San Francisco in 1915.

Resolved: that a committee be appointed for the proposed San Francisco meeting of the association in 1915, this committee to be known as "The Committee on the Pacific Coast Meeting."

The president later appointed on this committee the following:

Wm. Wallace Campbell, Sc.D., LL.D., director of the Lick Observatory, Mt. Hamilton, Cal., *chairman;* John Casper Branner, Ph.D., LL.D., professor of geology, Leland Stanford University; Wm. Alanson Bryan, president Pacific Scientific Institution, Honolulu; Henry Smith Carhart, Sc.D., LL.D., Pasadena, Cal.; Charles Lincoln Edwards, Ph.D., University of Southern California, Los Angeles, Cal.; Professor Wm. Trufont Foster, president of Reed College, Portland, Ore.; Geo. Ellery Hale, Sc.D., LL.D., director of the Mt. Wilson Observatory, Pasadena, Cal.; Mellen Woodman Haskell, Ph.D., professor of mathematics, University of California; Eugene Waldemar Hilgard, Ph.D., emeritus director of the College of Agriculture, University of California; Geo. Holmes Howison, LL.D., professor of philosophy, University of California; Oliver Peebles Jenkins, professor of physiology, Stanford University; David Starr Jordan, M.D., Ph.D., LL.D., president of Stanford University; Thos. Franklin Kane, Ph.D., president of the University of Washington; Lyman Vernon Kellogg, professor of entomology, Stanford University; Chas. Atwood Kofoid, Ph.D., professor of zoology, University of California; Alfred L. Kroeber, Ph.D., Affiliated Colleges, San Francisco, Cal.; Andrew Cowper Lawson, professor of geology and mineralogy, University of California; E. Percival Lewis, Ph.D., professor of physics, University of California; Jas. Harvey McBride, M.D., Pasadena, Cal.; Daniel Trembly McDougal, Ph.D., LL.D., Desert Botanical Laboratory, Tucson, Ariz.; Lillien J. Martin, professor of psychology, Stanford University; John Campbell Merriam, Ph.D., professor of paleontology, University of California; Agnes Claypool Moody, Ph.D., Berkeley, Cal.; John Muir, LL.D., Martinez, Cal.; Wm. Emerson Ritter, Ph.D., director of the Marine Biological Station, San Diego, Cal.; Harris Joseph Ryan, professor of electrical engineering, Stanford University; Fernando Sanford, professor of physics, Stanford University; William Albert Setchell, Ph.D., professor of botany, University of California; John M. Stillman, Ph.D., professor of chemistry, Stanford University; Benjamin Ide Wheeler, president of the University of California.

The committee on policy presented the following, which was adopted:

Resolved: that it be recommended that the council authorizes the committee on the Pacific Coast meeting proposed for 1915, to hold in the name of the association meetings of its members resident in that region, for the purpose of considering the relations of the association to the exposition in question, and if desirable, for the presentation of scientific programs. The expenses incurred shall be met from funds in the hands of the permanent secretary to such extent as may be approved by the committee on policy.

The following grant was allowed:

To the Concilium Bibliographicum . $200

A report of progress in the study of fish scales was received from Prof. Theo. D. A.

Cockerell to whom a grant of $75.00 had been made.

A report was received from Mr. Charles Peabody, delegate of the association to the XIV. Congress International d'Anthropologie et Archeologie Prehistorique, which was held in Geneva, September 9–14, 1912.

The council passed the following resolution on "Expert Testimony," presented jointly by Dr. M. G. Lloyd and Dr. J. A. Holmes:

Resolved: that a special committee of five be appointed by the president to collect and study data covering the practise in different countries relative to the employment of expert testimony in court procedure, and to cooperate in joint committee with representatives of other national organizations in studying this question with a view to submitting recommendation for new state and national legislation concerning the same;

That the permanent secretary of the association extend to other national organizations interested in this subject an invitation from this association to appoint a member on said joint committee, and to cooperate further with this association in taking such action relative to this matter as will best promote public interest;

That this social committee of five shall report both its findings and the findings of the joint committee, and also such action as may be taken by other organizations to the council of the American Association for the Advancement of Science at its meeting in January, 1914.

The council adopted the following, introduced by Professor H. B. Ward:

Resolved: That the council refer to the committee on policy the question of granting to secretaries of sections, the general secretary, and the secretary of the council, a mileage allowance in addition to the hotel allowance now made, and that the council empower the committee to take such action as may seem wise after investigation of the subject.

The following resolution, introduced by Dr. J. A. Holmes, was adopted by the council:

Resolved: that a special committee of five be appointed by the president to consider and report to the committee on policy a plan for the more rapid increase in the membership of the association.

That the committee on policy is hereby authorized to employ an associate secretary at a salary not to exceed $3,000 per annum, whose traveling expenses shall also be paid out of the treasury not to exceed $800 per annum and whose special duty it shall be to carry forward this extension work.

The committee on policy is hereby authorized to adopt, if necessary, such method as it may deem best for collecting additional funds for meeting such expenditure as may be needed.

The president later appointed on this committee the following: Messrs. J. A. Holmes, Chas. Baskerville, Hugh M. Smith, H. B. Ward, H. W. Springsteen.

The council adopted the following resolutions, introduced by Dr. J. McK. Cattell:

Resolved: that the council of the American Association for the Advancement of Science requests the educational institutions, government bureaus and other agencies engaged in scientific research to send one or more delegates to the annual convocation week meetings of the association and its affiliated societies, and that when possible the traveling expenses of the delegates be paid by the institutions which they represent.

Resolved: that a committee of three be appointed by the chair to draw up a list of institutions to which this resolution, together with a suitable letter, shall be sent by the permanent secretary.

The following were elected as members of the council to serve for three years: Messrs. J. McK. Cattell, J. M. Coulter and N. L. Britton.

At a meeting of the general committee held Thursday evening, January 2, invitations for future meetings were received from Atlanta, Philadelphia, Nashville, St. Louis, San Francisco, Leland Stanford, University of California, Portland, Seattle, Niagara Falls, Cincinnati, Columbus and Denver.

It was resolved to hold the next meeting in Atlanta, Georgia. It was further resolved to recommend to the next general committee that the meeting for 1914 be

held at Philadelphia, and that a summer meeting be held at San Francisco in 1915.

The following officers were elected for the coming year:

President: E. B. Wilson, Columbia University, New York.

Vice-Presidents:

Section A—Frank Schlesinger, Allegheny Observatory.

Section B—A. D. Cole, Ohio State University.

Section C—A. A. Noyes, Massachusetts Institute of Technology.

Section D—O. P. Hood, U. S. Bureau of Mines, Washington, D. C.

Section E—J. S. Diller, U. S. Geological Survey.

Section F—A. G. Mayer, Carnegie Institution of Washington.

Section G—H. C. Cowles, University of Chicago.

Section H—W. B. Pillsbury, University of Michigan.

Section L—P. P. Claxton, U. S. Commissioner of Education.

General Secretary: H. W. Springsteen, Western Reserve University.

Secretary of the Council: W. A. Worsham, Jr., University of Georgia.

Secretaries of Sections:

Section A—F. R. Moulton, University of Chicago.

Section D—A. H. Blanchard, Columbia University.

Section F—H. V. Neale, Knox College.

Section G—W. J. V. Osterhout, Harvard University.

Section H—George G. MacCurdy, Yale University.

Section L—S. A. Courtis, Detroit, Michigan.

Place of next meeting: Atlanta, Georgia.

Date of next meeting: Convocation Week, 1913–14.

At the general session, held Friday morning at Western Reserve University, the following resolutions were adopted:

Resolved: that the American Association for the Advancement of Science extend to the authorities of Western Reserve University and to those of the Case School of Applied Science, to the Board of Education and the Director of Public Schools, to the Mayor of Cleveland, to the local committee in charge of the arrangements for the third Cleveland meeting of the association, now about to close, and especially to the ladies' reception committee and to the authorities of the different industrial plants which have been opened to the inspection of members, the hearty thanks of the association for the admirable arrangements made, the excellent facilities offered, and the delightful courtesy and hospitality which have been extended by all and which have been highly instrumental in making this third Cleveland meeting one of the most successful which the association has held in recent years.

H. E. SUMMERS,
General Secretary

HEREDITY AND RESPONSIBILITY[1]

ONE of the greatest and most far-reaching themes which has ever occupied the minds of men is the problem of development. Whether it be the development of a chicken from an egg, of a race or species from a preexisting one, or of the body, mind and institutions of man, this problem is everywhere much the same in fundamental principles, and knowledge gained in one of these fields must be of value in each of the others. Familiarity with development does not remove the real mystery which lies back of it, though it may make plain many of the processes concerned. The development of a human being, of a personality, from a germ cell seems to me the climax of all wonders, greater even than that involved in the evolution of a species or the making of a world.

We are all familiar with the historic attempts which have been made to solve this problem. The old doctrine of evolution, or preformation, solved it by practically denying development; the doctrine of epigenesis recognized development but did not explain it. The one found all organs and parts present in the germ, which needed merely to grow and unfold to bring them

[1] Presidential address before the American Society of Naturalists, Cleveland, O., January 2, 1913.

to maturity; the other found the germ simple and homogeneous, but required some unknown force, some *spiritus rector* or *vis essentialis*, to cause the homogeneous to become heterogeneous. The one placed all emphasis upon the germ, the other upon outside forces or conditions.

Modern students of development recognize that neither of these extreme views is true—adult parts are not present in the germ, nor is the latter homogeneous—but for more than a hundred years opinions have been vibrating in the field between these two extremes.

Students of development, whether it be that of the individual or of the race, are like those ancient mariners who sailed that dreaded strait on the one side of which frowned Scylla and on the other roared Charybdis—in shunning the Scylla of preformation they run into the Charybdis of epigenesis, in avoiding the rocks of predetermination they fall into the whirlpools of no-determination, in avoiding the perils of fatalism they encounter the dangers of chaotic freedom—while the narrow channel of truth runs somewhere between these two extremes. They tack from one side to the other, ever advancing, ever leaving old dangers behind, ever meeting new ones—and so the science of development zig-zags on.

At present there can be no doubt that we are sailing nearer the preformation coast than at any time since the modern study of development began under von Baer. In the study of heredity great emphasis is placed, and necessarily so, upon the complexity of the germ and the intrinsic factors of development. There can be no doubt that the main characteristics of every living thing are unalterably fixed by heredity. Men differ from horses or turnips because of their inheritance. Our anatomical, physiological and psychological possibilities are predetermined in the germ cells. Whatever the ultimate relations of mind and body may be, there can be no reasonable doubt that both have developed together from the germ and that the laws of inheritance apply to one as certainly as to the other. The main characteristics of our personalities are born with us and can not be changed except within relatively narrow limits. "The leopard can not change his spots nor the Ethiopian his skin," and "though thou shouldst bray a fool in a mortar with a pestle yet will not his foolishness depart from him." Race, sex, character are predetermined in the germ cells, perhaps in the chromosomes, and all the possibilities of our lives are there fixed, for who by taking thought can add one chromosome, or even one determiner, to his organization?

These modern theories of heredity are profoundly influencing human thought in many fields. We formerly heard that all men were created free and equal; we now learn that all men are created bound and unequal. We were once taught that voluntary acts, if oft repeated, become habits, and that habits determine character; we now learn that acts, habits and character were foreordained from the foundation of the family. We once thought that men were free to do right or wrong, and that they were responsible for their deeds; now we learn that our reactions are predetermined by heredity and that we can no more control them than we can control our heart beats. For ages men have believed in the influence of example, in the uplift of high ideals, in the power of an absorbing purpose; for ages men have lived and died for what they believed to be duty and truth, and have received the homage of mankind; or they have lived malevolent and criminal lives and have been despised

by men and punished by society. But if our reactions, habits, characters are predetermined in the germ plasm such men have deserved neither praise nor blame. If personality is determined by heredity alone, all teaching, preaching, government, is useless; freedom, responsibility, duty are delusions; whether men are useful or useless members of society depends upon their inheritance, and the only hope for the race is in eugenics—always supposing that enough freedom is left to men or to society to control the important function of choosing a mate.

Already a few enthusiastic persons have begun to apply these doctrines to practical affairs. We are told that children should never be admonished or punished, for they do only what their natures lead them to do; the nature of the child must be respected and must be allowed to manifest itself in its own way. Lying and stealing will cure themselves like the mumps, or they will remain incurable, in which case the germ plasm is to blame and nothing could have been done, anyway. Laziness is due to inheritance or to parasites; the latter kind may be cured, but not the former. Thriftlessness, alcoholism and uncleanness run in families and can be cured only by extermination. Men who prey upon society were born with wolfish instincts, and can not help but eat the lambs. Villains, lawbreakers, murderers should be pitied but not punished; if blame attaches to their deeds it falls upon the marriage bureau and the parents. The world needs hospitals and sanatoria and sterilization institutes for the criminals and vicious, but not courts and prisons, and all punishments should be visited only upon the parents to the third and fourth generations.

Do our studies of heredity lead us to any such radical conclusions? If they do we must accept them like brave men. "Truth is truth if it sears our eyeballs." But when theories lead to such revolutionary results it behooves us to examine carefully those theories to see if there is not somewhere a fundamental flaw in them. Have we not sailed a little too close to the preformation coast and grounded our ship on the rocks of predetermination?

One of the most difficult things in the world is to recognize a great truth, to feel its significance, and yet not be carried away by it. Great scientific errors are frequently due not so much to faulty observations as to sweeping conclusions. In biology the search for universal laws is a peculiarly dangerous pursuit. In philosophy great errors are often due not so much to false premises as to supposed logical necessities. A logical chain has led many a man into the bondage of error. Truth is not usually found in extremes, in "carrying out a process to its logical conclusions," but rather in some middle course which is less striking but more judicious.

Having observed that the main characteristics of our minds as well as of our bodies are inherited, it is easy and natural to go further and to conclude that not only all the possibilities of our lives are marked out in the germ, but that all that will actually develop from the germ is there determined and can not be altered. There are many similarities between such an extreme view and the old doctrine of preformation, and it contains a like absurdity. It practically denies development altogether. If the germ is a closed system and receives nothing from without, and if adult characteristics are predetermined in the germ, they are as irrevocably fixed as if they were predelineated.

At the opposite extreme is the view with which we are all familiar, viz., the will is absolutely free; no taint of heredity rests

on the mind or soul; character is a *tabula rasa* on which the self writes its own record as it pleases and is responsible for the result. This view, like the old epigenesis, virtually postulates a new creation for each individual. So far as the mind and soul are concerned there is no hereditary continuity with past generations and none with future ones. But while such a view may be logically complete and theologically satisfying, it is not scientific, for it contradicts the evidence.

The truth then seems to lie somewhere between these two extremes. Our personalities were not absolutely predetermined in the germ cells from which we came, and yet they have arisen from those germ cells and have been conditioned by them. When it is said that any characteristic is predetermined in the germ cell, what does this mean? What but that the development of that characteristic is made possible? Adult characteristics are potential and not actual in the germ, and their actual appearance depends upon many complicated reactions of the germinal units with one another and with the environment. In short, our actual personalities are not predetermined in the germ cells, but our possible personalities are.

In all organisms the potentialities of development are much greater than the actualities. In many animals a small part of the body is capable, when separated from the remainder, of producing a whole body, though this potency would never have become an actuality except under the stimulus of separation. In like manner a part of an egg may, when separated from the remainder, give rise to an entire animal. By modifying the conditions of development animals may be produced which have one eye, many eyes, or no eyes; animals in which the bodies are turned inside out or side for side; animals in which all sorts of dislocation of organs have taken place; and the earlier the environmental forces act the more profound are the modifications produced. But leaving out of account all forms which are so monstrous that they are incapable of reaching maturity, we find that there are left many variations in the size and vigor of the body as a whole, as well as of its parts; many variations in the more or less perfect correlation of these parts with one another, which were determined by the conditions of development rather than by heredity. In a given germ cell there is the potency of any kind of organism that could develop from that cell under any kind of conditions. The potencies of development are much greater than the actualities. Anything which could possibly appear in the course of development is potential in heredity, and under given conditions of environment is predetermined. Since the environment can not be all things at once, many hereditary possibilities must remain latent or undeveloped. Consequently the results of development are not determined by heredity alone, but also by extrinsic causes. Things can not be predetermined in heredity which are not also predetermined in environment.

Functional activity, or use, is one of the most important factors of development. Functional activity is response to stimuli, which may be external or internal in origin. The entire process of development may be regarded as an almost endless series of such responses on the part of the organism, whether germ cell, embryo, or adult, to external and internal stimuli. It is a truism that use strengthens a part and disuse weakens it; it is likewise a truism that responses which are oft repeated become more rapid and more perfect, and in this way habits are formed. Practically all education, whether of man or of lower ani-

mals, consists in habit formation, in establishing constant relations between certain external or internal stimuli and certain responses of the organism. At first these stimuli are largely of external origin; later the external stimuli may be replaced more and more by internal ones; but whatever the source of the stimulus, the response of the organism to these stimuli is one of the most important factors of development, whether of the body or of the mind.

Among organisms a given cause does not always produce the same effect; this does not necessarily involve any violation of the law of causality, since it is highly probable that in responding to a stimulus the organism itself undergoes some change, and in subsequent repetitions of the stimulus, responses may differ because the organism is itself different. This is what is meant by "summation of stimuli," "physiological states," etc. Even in some of the simplest organisms one can observe inhibitions of responses and modifications of behavior, which seem to be due to conflicting stimuli, or to changes in the physiological state. In higher organisms such inhibitions or modifications proceed particularly from internal stimuli, which in turn are probably conditioned by hereditary constitution and past experience. The factors which determine behavior are not merely the present stimulus and the hereditary constitution, but also the experiences through which the organism has passed and the habits which it has formed.

By responsibility in the higher sense I understand the ability on the part of the individual to respond to rational, social and ethical stimuli, or impulses, and to inhibit responses to stimuli of an opposite nature; and the corresponding expectation on the part of others that the individual will so respond. The higher the type of organization the larger is the range of stimuli to which it will respond and the larger the number and kind of responses which may be called forth; and at the same time the larger becomes the power of inhibition of responses, whether through the balancing of one stimulus against another or from whatever cause. Human responsibility varies with the complexity of the stimuli involved, as well as with the capacity of individuals to respond to those stimuli. A man might be quite responsible in savage society, who would be quite irresponsible in civilized communities. In an infant there is no capacity to respond to rational, social or ethical stimuli, but with increasing capacity in this respect comes increasing responsibility. Mental and ethical imbeciles, insane and mentally defective persons, have a low capacity for such responses and inhibitions, and consequently less is expected of them. There are in different men all degrees of responsibility, as there are all degrees of capacity. In one and the same individual responsibility varies at different times and under different circumstances; it rises and falls, like the tides, in every life. Varying capacity to respond to rational, social and ethical stimuli, and to inhibit responses of an opposite nature depends not merely upon inheritance, but also upon training, habits, physiological states. The common opinion that all normal men are equally responsible is not correct; in the eyes of the law this may be true, but legal obligations are so far below the capacities of normal men that all may be held equally responsible before the law, though in reality their responsibilities are as varied as their inheritance or their training.

Conversely the responsibility of society to the individual is universally recognized. Irresponsible persons must be cared for by older or wiser persons who become responsible for them; and in general the responsi-

bility rests upon society to provide as favorable environment as possible for all its members. Experienced persons can to a certain extent choose their own environment and thus indirectly control their responses and habits, but young children are almost, if not quite, as incapable of choosing their environment as of choosing their heredity, and it becomes the duty of society to see to it that the environmental stimuli are such as to develop rational, social and ethical habits rather than the reverse.

Of all animals I suppose that man enjoys the most extensive and most varied environment, and its effect upon his personality is correspondingly great. Of all animals man has the longest period of immaturity and it is during this period that the play of environmental stimuli on the organism is effective in modifying development. In addition to the material environment he lives in the midst of intellectual, social and moral stimuli which are potent factors in his development. By means of his power to look before and after he lives in the future and past as well as in the present; through tradition and history he becomes an heir of all the ages. The modifying influences of all these environmental conditions on personality is very great. Each of us may say with Ulysses: "I am a part of all that I have met." So great is the power of environment on the development of personality that it may outweigh inheritance; a relatively poor inheritance with excellent environmental conditions often produces better results than a good inheritance with poor conditions. Of course no sort of environment can do more than to bring out the hereditary possibilities, but, on the other hand, those possibilities must remain latent and undeveloped unless they are stimulated into activity by the environment.

Not only the possibilities of development, but also the actual, developed capacities of men, are much greater than the habitual demands which are made upon them. How often have we surprised ourselves by doing some unusual or prodigious task! What we have once done we feel that we can do again. We realize more or less clearly, depending upon our experience, that what we habitually do is far less than we could do. It is this reserve, upon which we can draw on special occasions, that gives us the sense of freedom. I well remember a conversation which I once had with the late Dr. William Pepper. He had asked me to undertake a task which I felt incapable of performing, and I had pleaded inability, lack of time, anything to escape the responsibility. But with a confidence born of experience he said to me, "You know we *can* do what we *have* to do." In his inspiring address on "The Energies of Men," William James showed that we have reservoirs of power which we rarely tap, great energies upon which we seldom draw, and that we habitually live upon a level which is far below that which we might occupy. Darwin held the opinion, as the result of a lifetime of observation, that men differ less in capacity than in zeal and determination to utilize the powers which they have. In playful comment on the variety and extent of his own life work he said, in modest and homely phrase, "It is dogged as does it." It may be objected that the zeal and determination were inherited, but here also the hereditary possibilities become actualities only as a result of use, training, habit.

It is generally admitted that no constant distinction can be recognized between the brain of a philosopher and that of many a peasant. Neither size nor weight of brain, nor complexity of convolutions, bears any constant relation to ignorance or intelli-

gence, though doubtless an "unlimited microscopist" could find differences between the trained and the untrained brain. The brains of Beethoven, Gauss and Cuvier, although unusually large, have been matched in size and visible complexity by the brains of unknown and unlearned persons—persons who were richly endowed by nature, but who had never learned to use their talents. In all men the capacity for intellectual development is probably much greater than the actuality. The parable of the talents expresses a profound biological truth: men differ in hereditary endowments, one receives ten talents and another receives but one; but the used talent increases many fold, the unused remains unchanged and undeveloped. Happy is he who is compelled to use his talents; thrice happy he who has learned how to compel himself! We shall not live to see the day when human inheritance is greatly improved, though that time will doubtless come, but in the meantime we may console ourselves by the thought that we have many half-used talents, many latent capacities, and although we may not be able to add to our inheritance new territory, we may greatly improve that which we have.

I have once or twice in this address referred to eugenics in a way which was intended to be facetious, but I would not wish to be understood as attempting to disparage that infant industry. Undoubtedly it represents an important application of biological discoveries to human welfare; but it seems to me that it can not wisely go farther at this time than to attempt to eliminate from reproduction the most unfit members of society. Giving advice regarding matrimony is proverbially a hazardous performance, and it is not much safer for the biologist than for others. With a more complete knowledge with regard to the inheritance of human defects than we now possess, at least in many instances, it will probably be possible to give such advice wisely; but apart from certain bodily peculiarities, he would be a bold prophet who would undertake to predict the type of personality which might be expected in the children of a given union. Some very unpromising stocks have brought forth wonderful products. Could any one have predicted Abraham Lincoln from a study of his ancestry? Observe I say *predict*, and not explain after his appearance. Can any one now predict from what kind of ancestral combinations the great scholars, statesmen, men of affairs of the next generation will come? Could the capacities and careers of the members of this society—those who were born outside of Boston or Philadelphia—have been predicted? The time may come when it will be possible to predict what the chances are that the children of given parents will inherit more or less than average intellectual capacity, but since germinal potentiality is transformed into intellectual ability only as the result of development, such a prediction could not be extended to the latter unless the environment as well as the heredity were known. Society can safely eliminate its worst elements from reproduction, but it can not wisely go farther than that at present.

My distinguished predecessor in this office, in his striking address before this society one year ago, pointed out as one of the great tragedies of life the almost infinite slaughter of potential personalities in the form of germ cells which never develop. A more dreadful, though less universal, tragedy is the loss of real personalities who have all the native endowments of genius and leadership, but who for lack of proper environmental stimuli have remained undeveloped and unknown; the "mute, inglorious Miltons" of the world; the Cæsars,

Napoleons, Washingtons who might have been; the Newtons, Darwins, Pasteurs who were ready formed by nature, but who never discovered themselves. One shudders to think how narrowly Newton escaped being an unknown farmer, or Faraday an obscure bookbinder, or Pasteur a provincial tanner. In the history of the world there must have been many men of equal native endowments who missed the slender chance which came to these. We form the habit of thinking of great men as having appeared only at long intervals, and yet we know that great crises always discover great men. What does this mean but that the men are ready formed and that it requires only this extra stimulus to call them forth? To most of us heredity has been kind—kinder than we know. The possibilities within us are great but they rarely come to full epiphany.

What is needed in education more than anything else is some means or system which will train the powers of self discovery and self control. Easy lives and so-called "good environment" will not arouse the dormant powers. It usually takes the stress and strain of hard necessity to make us acquainted with our hidden selves, to rouse the sleeping giant within us. How often is it said that the worthless sons of worthy parents are mysteries; with the best of heredity and environment they amount to nothing; whereas the sons of poor and ignorant farmers, blacksmiths, tanners and backwoodsmen, with few opportunities and with many hardships and disadvantages become world figures. Probably the inheritance in these last-named cases was no better than in the former, but the environment was better. "Good environment" usually means easy, pleasant, refined surroundings, "all the opportunities that money can buy," but little responsibility and none of that self discipline which reveals the hidden powers, and which alone should be counted good environment. Many schools and colleges are making the same mistake as the fond parents; luxury, soft living, irresponsibility are not only allowed, but are encouraged and endowed —and by such means it is hoped to bring out that in men which can only be born in travail. College athletics has this much at least in its favor, that it trains men who take part in the contests to do their best, to subordinate pleasure, appetite, the desire for a good time, to one controlling purpose, it trains them to attempt what may often seem to them impossible, to crash into the line though it may seem a stone wall, to get out of their bodies every ounce of strength and endurance which they possess. Such training makes men acquainted with their powers and teaches courage, confidence and responsibility. If only we could make young persons acquainted in some similar way with their hidden mental and moral powers, what a race of men and women might we not have without waiting for that uncertain day when the inheritance of the race will be improved! Whatever the stimulus required, whether pride or shame, fear or favor, ambition or loyalty, responsibility or necessity, education should utilize each and all of these to teach men self knowledge and self control.

But it will be said that self control depends upon inheritance, that strong wills and weak wills are such because of heredity. It is true that one man may be born with a potentiality for self control which another man lacks, but in all men this potentiality becomes actuality only through development, one of the principal factors of which is use, or functional activity. An amazing number of persons have but little self control. Is this always due to defective inheritance, or is it not frequently the result of bad habits, of arrested develop-

ment? To charge defects at once to heredity removes them from any possible control, helps to make men irresponsible, excuses them for making the least of their endowments. To hold that everything has been predetermined, that nothing is self determined, that all our traits and acts are fixed beyond the possibility of change is an enervating philosophy and is not good science, for it does not accord with the evidence. It is amazing that men whose daily lives contradict this paralyzing philosophy still hold it, as it were, in some water-tight compartment of the brain, while in all the other parts of their being their acts proclaim that they believe in their powers of self control: they set themselves hard tasks, they overcome great difficulties, they work until it hurts, until they can say with Johannes Müller, "Es klebt blut an der Arbeit," and yet in the philosophical compartment of their minds they can say that it was all predetermined in heredity and from the foundations of the world. Whether all the phenomena of life and of mind can be explained on the basis of a purely mechanistic hypothesis or not, that hypothesis must square with the facts and not the facts with the hypothesis. It has always been true of those who "sat apart and reasoned high of fate, free will, foreknowledge absolute" that they have "found no end in wandering mazes lost." Whatever the way out of these mazes may be—whether it be found in the varied responses of an organism to the same stimulus, in the immense complexity of the mechanism involved, or in some form of idealism which finds necessity not in nature but in the spectator, and freedom not in the spectator but in the agent—it is true that for those who do not "sit apart and reason high," but who deal merely with evident phenomena, the way out of these mazes is not to be found in denying the actuality of inhibition, attention, and control. Because we can find no place in our philosophy and logic for self determination shall we cease to be scientists and close our eyes to the evidences? The first duty of science is to appeal to fact, and to settle later with logic and philosophy. Is it not a fact that the possibilities of our inheritance depend for their realization upon development, one of the most important factors of which is use, functional activity, in response to stimuli? Is it not a fact that our capacities are very much greater than our habitual demands upon them? Is it not a fact that belief in our responsibility energizes our lives and gives vigor to our mental and moral fiber? Is it not a fact that shifting all responsibility from men to their heredity or to that part of their environment which is beyond their control helps to make them irresponsible?

This debilitating philosophy in which everything is predetermined, in which there is no possibility of change or control, in which there is hypertrophy of intellect and atrophy of will, is a symptom of senility, whether in men or nations. We need to return to the joys of a childhood age in which men believed themselves free to do, to think, to strive, in which life was full of high endeavor and the world was crowded with great emprise. We need to think of the possibilities of development as well as of the limitations of heredity. Chance, heredity, environment have settled many things for us; we are hedged about by bounds which we can not pass; but those bounds are not so narrow as we are sometimes taught, and within them we have a considerable degree of freedom and responsibility.

That which we are we are,
One equal temper of heroic hearts
Made weak by time and fate, but strong in will
To strive, to seek, to find, and not to yield.

EDWIN G. CONKLIN
PRINCETON, N. J.

SCIENTIFIC NOTES AND NEWS

PROFESSOR E. B. WILSON, of Columbia University, was elected president of the American Association for the Advancement of Science at the Cleveland meeting. A report of the meeting and a list of the other officers elected will be found above. National scientific societies meeting at Cleveland elected presidents as follows: The American Physical Society, Professor B. O. Peirce, of Harvard University; the American Botanical Society, Professor D. H. Campbell, of Stanford University; the American Psychological Association, Professor C. H. Warren, of Princeton University; the Society of the Sigma Xi, Professor J. McKeen Cattell, of Columbia University; the American Society of Naturalists, Professor Ross G. Harrison, of Yale University.

AT the annual election of the American Philosophical Society held on January 3, 1913, the following were elected:

President: William W. Keen.

Vice-presidents: William B. Scott, Albert A. Michelson, Edward C. Pickering.

Secretaries: I. Minis Hays, Arthur W. Goodspeed, Amos P. Brown, Harry F. Keller.

Curators: Charles L. Doolittle, William P. Wilson, Leslie W. Miller.

Treasurer: Henry La Barre Jayne.

Councillors: Charlemagne Tower, William Morris Davis, George Ellery Hale, R. A. F. Penrose, Jr., Samuel W. Pennypacker.

THE eighty-first annual meeting of the British Medical Association will be held in Brighton beginning July 22. Dr. W. A. Hollis, consulting physician, Sussex County Hospital, is the president-elect. The address in medicine will be delivered by Professor G. R. Murray, physician to the Royal Infirmary, Manchester. The address in surgery will be delivered by Sir Berkeley Moynihan, professor of clinical surgery in the University of Leeds. The popular lecture will be delivered by Mr. E. J. Spitta.

THE John Fritz medal, awarded annually by the four great engineering societies, has been awarded this year to Mr. Robert Woolston Hunt for his contributions to the development of the Bessemer steel process.

THE Academy of Medicine, Paris, has elected Professor Delezenne an honorary member of the section on anatomy and physiology to fill the vacancy caused by the death of Professor Marc Sée.

DR. W. E. BYERLY, Perkins professor of mathematics at Harvard University, will become professor emeritus at the close of the academic year.

DR. CARL PAAL, director of the laboratory for applied chemistry at Leipzig, and Dr. Fritz Förscher, director of the laboratory for inorganic chemistry in Dresden Technical School, have been elected members of the Leipzig Academy of Science.

PROFESSOR ANDREW BOSS, in charge of the department of farm management of the department of agriculture of the University of Minnesota, has declined an offer to become director of the new government demonstration farms and trial gardens at Mandan, N. D.

PROFESSOR CHARLES PALACHE, of Harvard University, using a fund placed at his disposal by A. F. Holden, '88, has spent six weeks in Maine and New Hampshire collecting minerals for the Mineralogical Museum and the teaching collections.

ASSOCIATE PROFESSOR FREDERICK STARR, of the department of sociology and anthropology in the University of Chicago, has returned from a six months' expedition to Liberia, the purpose of which was to investigate the social and economic conditions of that region. He was accompanied by Mr. Campbell Marvin, a graduate student of the university.

DR. THOMAS L. WATSON, professor of geology in the University of Virginia, addressed the graduate students in geology at Northwestern University, last month, on the "Occurrence and Geology of Rutile, with Special Reference to the Virginia Deposits."

DR. LEWIS SWIFT, formerly director of the Warner Astronomical Observatory at Rochester, and of the Mount Lowe Observatory on Echo Mountain, California, known for his discoveries of comets and nebulæ, died at Binghampton, N. Y., on January 5, aged ninety-three years.

Mr. Henry D. Mosenthal, a British chemist, known for his work on explosives, died on December 18, aged sixty-two years.

Dr. Rudolf Schimmack, docent for mathematics at Göttingen, has died at the age of thirty-two years.

The publishing house of Julius Springer, Berlin, announces the publication beginning with the new year of a new weekly journal "Die Naturwissenschaften," which, according to the announcement, "für den deutschen Wissenschaftsbetrieb ungefähr das leisten soll, was die 'Nature' für den englischen und die 'Science' für den amerikanischen leisten." The numbers will contain about 24 pages; the subscription price will be 24 Marks. The *Naturwissenschaftliche Rundschau*, edited by Professor W. Sklarek and published by Friedrich Vieweg und Sohn, which for twenty-seven years has maintained high scientific standards, will be merged in the new journal.

The number of visitors to the Zoological Gardens, London, for the past year exceeded 1,000,000, the highest on record, and in accordance with the intention of the Zoological Society the millionth person to pass the turnstiles was presented with a free pass to the gardens for 1913.

A meeting of the executive committee having charge of the arrangements for the British Association meeting in Birmingham next year was held, as we learn from the London *Times*, on December 5. Mr. Howard Heaton, on behalf of the honorary secretaries, presented an outline of the program, which included an average of five engagements each day for eight days, beginning on September 10. In addition to the usual business meetings and scientific discussions, there will be an inaugural address by the President (Sir William White) on Wednesday, a garden party and reception by the Lord Mayor on Thursday, a garden party given by Messrs. Cadbury at Bournville on Friday, excursions to places of interest in neighboring counties on Saturday, special services in the churches on Sunday, an entertainment by the local committee on Monday, and a garden party on Tuesday. For the benefit of the general public there will be two evening discussions and six popular lectures by eminent scientists during the week. The suggested program was adopted and referred to a sub-committee to be carried out. Sir George Kenrick presented the report of the finance sub-committee, which stated that the amount required to cover the local expenses of the meeting would probably be not less than £6,000. About half that sum had already been promised in response to private appeals by members of the finance sub-committee, and a public appeal would be issued at the beginning of the new year.

The Melbourne meeting of the Australasian Association for the Advancement of Science, as stated in *Nature*, will be held on January 7–14. The president-elect is Professor T. W. E. David, C.M.G., F.R.S., and the retiring president Professor Orme Masson, F.R.S. The meeting will be held at the university, which is surrounded by large grounds, and can provide ample accommodation. Professor Baldwin Spencer, F.R.S., who is spending the year as chief protector of aborigines in the Northern Territory, will deliver a lecture on some of the results he has obtained. A joint discussion of several sections will be held on the genus Eucalyptus and its products. A forest league is being formed in the various states, under the auspices of the association, which it is hoped will rouse public opinion to the necessity of preserving forests, especially round the head waters of the rivers. A large number of committees will present reports, and a full program of papers is expected. The following are the presidents of sections: Astronomy, Mathematics and Physics, Professor H. Carslaw; Chemistry, Professor C. Fawsitt; Subsection Pharmacy, Mr. E. F. Church; Geology and Mineralogy, Mr. W. Howchin; Biology, Professor H. B. Kirk; Geography and History, Hon. Thos. M'Kenzie; Ethnology and Anthropology, Dr. W. Ramsay-Smith; Social and Statistical Science, Mr. R. M. Johnston; Agriculture, Mr. F. B. Guthrie; Subsection Veterinary Science, Professor Douglas Stewart, Engineering and Architecture, Col. W. L. Vernon; Sanitary Science and Hygiene, Dr. T. H. A. Valintine; Mental Science and

Education, Sir J. Winthrop Hackett. The general secretary for the meeting is Dr. T. S. Hall.

PROFESSOR WALTER N. LACY, of the Anglo-Chinese College at Foochow, China, writes to Professor J. C. Branner, of Stanford University, the following in regard to the work of ants and termites in China. The paper referred to is published in the *Bulletin* of the Geological Society of America, Vol. 21, 449–496.

I have read with much pleasure your paper on the geologic work of ants in tropical America, for which I have to thank you. One or two items from this part of the world, regarding the termites or white ants may be of interest to you, although Foochow is in lat. 26° 58′ N.—not quite within the tropics.

On pages 478 and 479 you refer to the common ants being enemies of the white ants, and the two not thriving together. A friend of mine in the northwest part of this province has tried successfully placing black ants' nests under the house which was occasionally attacked by the white ants, and found that they were completely rid of the latter, without being in any way inconvenienced by the common ants.

On page 491 you say: "I am not aware that they (the white ants) ever attack living trees." It is not at all uncommon in these parts to find their mason-work passage-ways built up the trunks of growing trees. A few years ago an olive tree near our house was blown over in a typhoon, and it was discovered that the entire tree had been riddled by the white ants; although the tree trunk was from 18 to 24 inches in diameter, little had been left but the outer shell and bark of the tree and the leaves on the branches. For the white ants to do away with trees in this way is not rare, but, as you suggest, their work is not done in a night, but through a considerable period of time, without doubt.

UNIVERSITY AND EDUCATIONAL NEWS

GRINNELL COLLEGE received on December 24 a Christmas gift of $50,000. The money was made immediately available, to be used for any purpose, the donor stipulating but one condition, namely, that his name should never be made public.

MRS. JOHN HALL has given £500 to Sheffield University in memory of her husband. The income will provide each year a gold medal to be awarded to the student who does best in the subject of pathology at the examination for the degree.

THE university court of Edinburgh University has given a grant to Professor Whittaker for the equipment of a mathematical laboratory for the practical training of mathematicians and for a research institution. This will, it is said, be the first laboratory of its kind in a British university.

THE general council of the University of Edinburgh has taken action to bring before members of parliament and others interested in higher education the serious danger with which the universities of Scotland are threatened by the recent interference of the treasury with their freedom of internal administration.

CERTAIN citizens of Oberlin recently asked that the part of the endowment funds of Oberlin College invested in stocks and bonds should be listed for taxation. The decision ot the auditor of Lorain County has now been rendered in favor of the college, to the effect that according to the laws of the state of Ohio the college endowment funds can not be taxed.

AT Harvard University, Dr. Harvey Cushing has been appointed professor of surgery, and Dr. George Gray Sears, clinical professor of medicine. Professor Ralph B. Perry has been promoted to a professorship of philosophy.

W. S. HUNTER, Ph.D. (Chicago), has been appointed instructor in psychology in the University of Texas. F. A. C. Perrin, Ph.D. (Chicago), has been appointed instructor in psychology in the University of Pittsburgh.

MR. CHARLES FULLER BAKER, known for work in various fields of natural science, has entered the faculty of the College of Agriculture of the University of the Philippines as professor of agronomy. In the same college, Mr. A. G. Glodt, formerly of the engineer corps of the French army and a member of the Marchand relief expedition across Africa, is

associate professor of agricultural engineering. Mr. F. C. Gates, who recently finished the work for his doctorate at the University of Michigan, is instructor in botany. Mr. Edgar M. Ledyard, who spent the past year at the University of Michigan where he put the entomological collection in order and left some sixty thousand Philippine insects, has returned to his work as assistant professor in entomology. Dr. H. N. Whitford has resigned as associate professor of forest botany and silviculture, and has returned to the United States.

DISCUSSION AND CORRESPONDENCE

THE VOTE ON THE PRIORITY RULE

To the Editor of Science: A brief rejoinder may be permitted to the report by Messrs. Nutting, Williston and Ward in Science for December 13, on a vote on the rule of Priority in Nomenclature.

Primarily this vote shows something quite different from what might be inferred from a superficial examination of the report.

It means *not* that the voters have studied the conditions of confusion which the priority rule was instituted to clear up, and which produce the present temporary state of which there has been natural complaint; but that the teachers (of whom the list of voters is exclusively composed) are much annoyed by the uncertainty incident to the period of transition. This is nothing new; everybody has felt it; it requires an almost Roman firmness to give up a familiar if erroneous name; and the wonder is that the vote was not unanimous. Precisely the same state of mind is the cause why we have not yet adopted the metric system, and Russia retains the old style in her calendar.

If the question had been put as to what remedy should be had, other than continuing the work of rectification as rapidly as possible, it is likely there would have been as many minds as there were voters. No teacher likes to give a name to an organism before his classes which he is not certain is up to date. Moreover, some too clever pupil may discover that Jordan, Merriam, Allen, Elliot, Gill, Richmond, and other master systematists reject that name; where then is our infallibility? It is a tearful situation.

However, a complete remedy is at hand which will harmonize all the disputants without sacrificing accuracy or rejecting necessary rules.

It is well known that nearly all the vertebrates have what are called "common" or popular names. These have been carefully preserved by the ornithologists in their check-lists, for example.

Now let the dear old familiar names of each man's particular set of text-books be given the status of "common names," distinguished by (say a plus sign before them) to avoid confounding them with the real names, and have it generally admitted that no odium attaches to the use of a "common name" for our invertebrates, any more than in ornithology, and we have the whole problem solved. Since only one in a million invertebrates has a "common name" at present, no trouble would ensue on that score.

(I expect nothing less than a statue for this discovery, from future generations of teachers.)

Wm. H. Dall

Smithsonian Institution,
December 16, 1912

THE STAINING OF PROTOZOA

To the Editor of Science: Hæmatoxylin is, so to speak, the printer's ink of protozoologists, for this stain is used by all workers in studying the morphology of the cell, and it has come into general use because it tells as much as a single stain can of the essential structures in the architecture of a cell. It is true that various mordants alter, or rather intensify the staining character of certain parts of the nucleus. For example, when "agamous" trophozoites of *Entamœba tetragena* are stained by alum hæmatoxylin, iron hæmatoxylin, or phosphotungstic acid hæmatoxylin, or if they are stained with Mallory's phosphotungstic acid hæmatoxylin after wet fixation by Merkel's and Zenker's fluids, the different structures in the nucleus—

centriole, karyosome and sub-membranous granules, take the stain in different degrees, yet it is the same chemical basophilic substance that becomes stained.

Hæmatoxylin tells us nothing about the acidophilic substance which seems to play an important part in the physiology of the nucleus.

During the past year, working with *Entamœba tetragena,* I have been impressed by the lack of information in literature on the subject of the acidophilic substance in the nucleus of protozoa; and in descriptions of protozoa, I have noticed the frequency with which acidophilic substance has been confused with true chromatin (basichromatin). This appears to be due to the use of polychrome stains which have not been thoroughly differentiated, and to the absence of a satisfactory technique for demonstrating acidophilic substance in wet fixed films.

Those who have used the Romonowsky modifications have usually been content with over-toned or blurred pictures. In attempting to identify "*E. histolytica*" in this region and differentiate it from *E. tetragena,* our common pathogenic entamœba, I have used Romonowsky stains on films which have been so differentiated that excessive amounts of the stain have been washed out as one would differentiate preparations stained with hæmatoxylin. Inasmuch as Romonowsky stains have almost as much tendency to overstain as hæmatoxylin, the necessity for extraction of superfluous stain is manifest.

I have usually selected cover-slip preparations that contained a sufficient number of entamœbæ to warrant further study, and stained both cover-slip and object slide, thereby obtaining three pictures from one film, fresh, hæmatoxylin and polychrome. After staining, the excess of polychrome stain has been removed by means of 95 per cent. ethyl alcohol and ammoniated 60 per cent. alcohol, and I have found that when properly differentiated, the polychrome stain after dry fixation gives a picture entirely different from that of hæmatoxylin after wet fixation. It is different in two respects. It not only shows that there is an acidophilic substance—oxychromatin—within the nucleus quite different from anything yet described for *E. tetragena,* but the remainder and larger portion of the nucleus has a different structure and staining characters from that described from hæmatoxylin preparations of this entamœba.

The nucleus of *E. tetragena,* when stained with Hasting's stain followed by Giemsa's stain, and carefully differentiated with 60 per cent. ethyl alcohol, to which a few drops of aqua ammoniæ have been added (1 per cent. aqua ammoniæ in 60 per cent. alcohol) is seen to be made up of a clearly defined red substance which takes the form of a ring about the size of the karyosome or smaller. Oftener, it takes the form of a delicate reticulum or of discrete granules lying within the nuclear membrane. This red substance does not correspond in location with true chromatin (basichromatin) which stains with hæmatoxylin, and it should not be confused with basichromatin as some writers have done. The red substance, or oxychromatin, is imbedded in an ill-defined nuclear structure, staining faintly blue which sometimes is made up of slightly refractile achromatic granules of uniform size, imbedded in faintly staining blue substance and surrounded by an achromatic or faintly staining blue ring, corresponding with the nuclear membrane. The cytoplasm stains various shades of blue.

Attention is drawn to this subject with the suggestion that those interested in the cytology of protozoa pay more attention to the acidophilic substance of the nucleus—oxychromatin, for the purpose of learning what part it plays in relation to synchronous changes in the basichromatin of the nucleus and in the physiology of the cell.

It is extremely likely that so clearly defined a substance as the oxychromatin of the nucleus of *E. tetragena* is has an important physiological function, and it would seem that other protozoa might yield interesting and no doubt important information if studied from preparations designed to satisfactorily show basophilic and acidophilic nuclear substance.

SAMUEL T. DARLING

THE DORSAL SCALE ROWS OF SNAKES

IN these days when so much attention is being given to the variations and minute characters of animals it seems remarkable that such an important trait as the number of dorsal scale rows in the snakes should receive careless treatment. This character is given considerable weight in delineating species and deserves careful attention. From the descriptions one could only conclude that each species has a rather definite number, 17, 19 or 21, as the case may be, and that the variations are abrupt. The facts are far from being as simple as this. As a rule the number of scale rows decreases posteriorly, and there is often a decrease anteriorly, so that the maximum number of rows (the number now given in descriptions) may either extend from the head to beyond the middle of the body, or be restricted to a longer or shorter distance on the middle, sometimes only for the length of two or three scales. Furthermore, the species that exhibit a variation of two or more entire rows on the anterior part of the body also show the intermediate stages in which the extra rows are present on the middle of the body only, which leaves no doubt that the variations in this character are not abrupt but gradual.

From these facts it is evident that the average number of rows characteristic of a species in any region can only be expressed by a formula that gives the number of rows on the different parts of the body. It is not enough to say that a species has a maximum of 21 rows; one should at least know whether the number is 21 for the greater part of the length or only on the middle of the body. Quite evidently a form with an average of 21–19–17 scale rows, which means 21 to beyond the middle and 19 and then 17 posteriorly, is not the same as one in which the scale formula averages 19–21–19–17, any more than one with 21–19–17 rows is the same as one with 19–17 rows, although such variations are thrown together under the present way of recording the rows.

It is a simple matter to count the number of rows on the different parts of the body and this may be conveniently expressed by the formula given above. At least this much should be done by the herpetologist, if not for the systematist then for the student of geographic variation, for only with this data can one determine the variation in this character and the type in each locality.

ALEXANDER G. RUTHVEN
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THE QUESTION OF TEXT-BOOKS IN COMPOSITION

WHEN a Harvard man thinks of books on English composition he thinks of Professor Wendell, and before him Professor Hill, and before him the dark. Professor Hill's books, though immensely comforting and instructive, ought to be considered as reference books rather than as texts. Therefore, in the winter of 1890–91, when Professor Wendell found himself confronted with the problem of lecturing on composition to a Lowell Institute audience, he looked about him to see what had already been done. He was surprised to find that nothing then in print quite served the turn. All these earlier fellows were too technical and too much absorbed in detail. They laid down hard and fast rules. They had no patience with the growing tendency to say, "It is me." Students could scarcely tolerate their etymology, their prosody, their similes and their metaphors. Professor Wendell felt already, we may assume, something of his present fine impatience with the details of scholarship; he was already, on his academic side, professionally unconventional. Here, then, was a man peculiarly gifted by nature for the work of cleaning house in rhetoric. There resulted the Lowell lectures, and, in time, the "English Composition."

Since then nobody, I believe, has dared to depart from Professor Wendell's ways. We have had composition books written by nearly everybody, for nearly every important institution and academic grade; but none in any essential respect different from the first. Latterly they become more full of illustrative material and exercises. They present examples of faulty and correct writing from

every modern source, beginning with the newspapers and ending with Colonel Bryan and Sarah Orne Jewett. A few have made some additions to the original theory. They undertake to show a logical subdivision of the plans on which paragraphs may be built up. Beyond this there is little difference. The principles of composition, no matter who expounds them, still bear the hall-mark of their origin. They are all dilute and popular. They all present vague, sweeping precepts which relate to criticism, and not at all to the art of writing. These are so abstract that special exercises must be invented to illustrate them, and so lacking in specific helpfulness that any attempt seriously to fix the student's attention upon them quickly kills his desire to write. Between students who find them incomprehensible and those who think them obvious and silly, there is only a small middle class. It consists of those adapted by nature to take orders and obey with mechanical faithfulness.

Some ten years ago these words might properly have been regarded as destructive criticism. At present they can not, for there is little now left to destroy. Few successful teachers of composition now pay much attention to text-book work. Individual conferences with students have partly replaced it. These, however, are now taken for granted, and we no longer write to the papers about them. A newer device, and one even more welcome, because it occupies class-room hours, is "oral composition." Though burdened at the start with the most unattractive name that could have been chosen, "oral composition" has been an enormous success. More than one high-school teacher of English has seen it double the interest in his work. No wonder. It gives the student, what the text-book never furnished, a rational ideal and an intelligible standard by which to judge success.

The principles of English composition, while they lasted, were hardest on us teachers. We, at least, were forced to take them seriously. The burden of illustrating these mechanical rules fell on us. Now a great musician, one imagines, may go through his five-finger exercises, or what not, and by and by assimilate his technique and perform with the regulated freedom of genius. Whether it can be so with a writer will perhaps never be known. Certainly it can not be proved by us teachers of composition, for none of us was a genius to begin with. We arrive at a state of mechanical perfection in technique, and there we stick. I look back, in my own case, upon the ruin of a promising and individual, though not a solid or brilliant, style. Now-a-days I write with the mechanical regularity of one pumping into a bucket. I have been a faithful disciple of Professor Wendell, and I can now write a paragraph as "theoretically perfect in mass" as anything to be found in the *Nation*. I can write a paragraph explaining what a paragraph should be, and at the same time explaining that the paragraph I am writing illustrates what a paragraph should be; and I can bring both ideas together at the end into the same summary! But suppose me very angry, or very serious about my subject, so much disturbed, in fact, that I was beside myself, and forgot the principles of English composition. Could I then write any paragraph at all? Probably not. No more than a bricklayer could lay a brick without his trowel. Almost the only thing of which I am any longer capable is what Professor Wendell calls "a piece of style."

There should be comfort in the fact that I am not alone. Most of the brotherhood of English teachers is in the same state. If a man has taught composition any time these twenty years, he is marked. You recognize his method as far away as you can read his work. To conclude a paragraph with a summary is for him as unavoidable as to expel breath after inhaling. His style crawls over the page like an inch-worm, constantly measuring its heels up to its chin. I think of these things, and I wish I were upon the hill of Basan, to outroar the horned herd!

The possibility of slighting the text-book work is, of course, entirely agreeable to many teachers of English. They find it in keeping with modern methods in education. School

is let out, there are to be no more tasks, nothing but playing cross-tag with the boys in the yard and developing the "class consciousness." There is among us, as in other subjects, the type of man properly called an "educator." He "draws out" his pupils. Always animated, always with the last word from the *Scientific American* or the *Review of Reviews*, he makes his class-hour a little less interesting than the moving pictures, but more so than a star lecture at the Y. M. C. A. Such a man likes to see bright faces about him. He is accustomed to have his hour looked forward to with pleasure, his classes begging to be allowed to write ten pages, while he sternly holds out for five. His work is "inspirational"; to make it succeed, he must be in the best of physical condition. So he saves himself. He lets his students criticize their own compositions and those of one another. For himself, he resolves to read themes less, and to play golf more. Such a man is merely an accident in an English classroom. If his occupation were adapted to his essence, we should find him preaching on politics and current problems in a modern evangelistic city church. But, as he stands, his students look up to him as a polished gentleman and man of the world. From him they draw culture in the vaguer sense, a dissemination of sweetness and light.

Meanwhile, there is still the teacher. He is to be found in all subjects, even English composition. He hates inexactness and vagueness, he loves to enforce a clear intellectual distinction, he has great confidence in the educational value of abstract thought. On these accounts he is very unhappy, at the moment, in the English class room. The birch was taken away from him long ago, and now they have taken the book. His conference work goes well enough, being confined mostly to punctuation, grammar and the split infinitive; but in the class he finds nothing to do that he considers worth while. His text-book distresses him with its lack of content. How can he hold up his head before his classes as a man of intelligence when he is obliged to spend his hours with them in discussing principles which would be evident to the child of ten? He was better off in the dark ages, before they made the whole business so simple. Then, at least, there was material for mental exercise.

It is this style of man who does the real work of the schools, that for which parents suppose they are paying. He is less conspicuous than the "educator," for teaching is a curious business. It is the only profession in which men appear to succeed best by neglecting their work and doing other things. At the same time, as it is not now a question of promotion or salary, we may admit that this man of solid, thoughtful mind is the only real teacher. And the question comes up: What are we to do to keep him happy in English composition?

If we assume that no college teacher wants to do his plain duty, and teach spelling and grammar, there are still two other directions in which the outlook for new text-books is more or less hopeful. The first is logic. That subject has been for some time neglected, and now tends to seem a part of "the good old times." College teachers have begun to ask themselves whether they can not introduce some training in logical principles into the English course; though at the outset they are somewhat staggered at the memory of "Barbara, Celarent." Some day there will be a shaking among those dry bones, and then we shall have a text-book for the teacher.

The second direction from which light may come is the artistic treatment of prose. The artistic problem behind the student's theme, if he can be made to see it, will interest him. It will interest also the "educator" and the teacher. If we could find a man among us who is by nature an artist, rather than a critic, he might contrive to tell us how to write. This sort of book is the hardest of all to produce, and the least likely to appear; but, if one could make it, it would be worth as much as all that has yet been written.

A. T. Robinson

Institute of Technology,
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SCIENTIFIC BOOKS

Higher Mathematics for Chemical Students. By J. R. PARTINGTON. New York, D. Van Nostrand Co. 1912.

A first question is: Do chemists need any higher mathematics? And it must be admitted that the inorganic analytical chemist, the organic synthetic chemist, the agricultural chemist, and a host of others, by a large margin the majority of all, do not need much, if any, mathematics, and perhaps a quarter century ago no chemist was much the better off for a knowledge of the subject. Of late, however, there has been a great development of physical and dynamic chemistry, wherein mathematical methods are of great importance, so that there has come considerable demand for mathematics from a large and growing class of theoretical chemists, and the demand is likely to increase in the future. Indeed if a student desires to read such memoirs as that of Gibbs on the equilibrium of heterogeneous substances, he must have a tolerably thorough foundation in some branches of mathematics.

A second question: Is there any necessity for a special treatment of calculus for chemists? The appearance of such works as Mellor's "Higher Mathematics for Students of Chemistry and Physics" and this work of Partington's would seem to imply that there was. And the publication of special texts for engineers, economists and the like is evidence that others than chemists feel such a need. In this connection we may cite the excellent address by C. Runge at the International Congress of Mathematicians in Cambridge last summer on the university training of the physicist in mathematics. It is there pointed out with force, but kindness, that our mathematicians do not organize their course of instruction with sufficient reference to the advantages of the great majority of their students, namely, those who are going into physics, chemistry, economics, engineering, and, indeed, anything except pure mathematics—and in so organizing them they are not making for any very preponderating advantages for the few students of pure mathematics.

The sort of course in calculus that the elementary student of applied mathematics should have is one where the ideas and methods of differential and integral calculus, including differential equations, are most fully emphasized and thoroughly illustrated by simple formal work applied to a great variety of problems. For it must be remembered that nine tenths of the problems where the student will use his calculus can be treated with the simplest sort of analysis. So long as mathematicians insist upon a training in differentiation and integration which requires the exercise of a considerable amount of advanced algebra and analytical trigonometry, the student of the elementary applications will find himself burdened with unnecessary material which may be hard for him and which can not fail to distract his attention from the work he most needs. And just so long there will be attempts, justifiable attempts, to compile treatises out of the line of the regular mathematical courses for the use of such students.

Whenever a book thus intended for a special class appears it must be judged from a double point of view: First, how is it as mathematics; second, how does it meet the needs of that special class?

Judged from the point of view of the mathematician, Partington's work is far from good; it has that sort of inaccuracy which indicates that its author, no matter how much he may use his mathematics, does not have any thorough knowledge of the subject; it abounds in the kind of glaring crudities with which every serious teacher is familiar on the part of his pupils and which he seeks constantly to eliminate, though often unsuccessfully, from their minds. A few instances must be cited to justify so sweeping a condemnation.

On page 21, in the definition of limit the statement that the variable can never reach its limit is incorporated. With the artificial discontinuous variable of elementary geometry this is true, though unessential; with the continuous variables of physics it is not true. On page 31 in varying the equation $pv = K$ by assigning increments to the variables the author writes

$$(p + dp)(v - dv) = K.$$

Now $v - dv$ in place of $v + dv$ is just the sort of error we have constantly to warn the freshman against. The increment dv may be negative, but should not be written as $-dv$. The author finds the correct result $dp/dv = -p/v$ incorrectly from an incorrect equation. On page 67 there is this choice bit: "At this point (such as P) there is a sudden change of direction; it is therefore called a *point of inflection*." A fine definition! How could the author have made more errors in so short a sentence! On page 86 we find: "It must not be supposed, however, that the series obtained by differentiating a convergent series term by term is also convergent. Thus the series

$$1 + x^1 + x^{1\cdot 2} + x^{1\cdot 2\cdot 3} + x^{1\cdot 2\cdot 3\cdot 4} + \cdots$$

is convergent for $|x| < 1$, but the series

$$1 + 2x + 6x^5 + \cdots,$$

obtained by differentiation, is divergent for all values of x." Now if there is any one fact better known or more fundamental than that a power series which converges is differentiable term by term and yields a convergent series, we fail to know what it is. This sort of mistake can arise only when ignorance is blatant enough to talk about matters of which it is so completely ignorant that it does not even recognize its ignorance. No author can wholly avoid errors, but here they are too many and too gross for any charitable inference.

But this book is intended for chemists, and in justice it should be judged chiefly upon what it does for them, what it gives them that they need, what it spares them that for them would be superfluous. Here we must admit that we think the work a great success. To the mathematician, the physicist or the electrical engineer the total omission of all reference to the circular functions and their inverses would seem incomprehensible. But the chemist has no need of oscillating functions; his phenomena run one way. The restraint that the author has exhibited in leaving entirely aside the trigonometric functions is therefore highly commendable. Again, the author uses differentials in differentiating and gives a tolerably full account of partial differentiation, of the total or exact differential, and of circuit integrals. These matters are of great importance to the chemist. Moreover, though his work is chiefly elementary calculus, it somewhat justifies the more general title Higher Mathematics by the introduction of methods of interpolation, extrapolation, approximation formulas and the like, and it finds place on almost every page to appeal to the chemist by selecting exclusively for its applications problems which actually arise in that subject.

The titles of the chapters will give an idea of the scope of the text. Functions and limits, rate of change of a function, differentiation of algebraic functions, maximum and minimum values of a function, exponential and logarithmic functions, partial differentiation, interpolation and extrapolation, the indefinite integral (two chapters), definite integrals, application of the definite integral, differential equations (two chapters), and appendices containing the theory of quadratic equations, the solutions of systems of linear equations by determinants, approximation formulas, and a tabulation of the exponential and natural logarithmic functions. As has been stated, everywhere are found detailed and vital applications to chemistry, to which the list of entries in the index bears ample witness. The student who masters the text will do so with the fullest appreciation of its use to him and will attain a knowledge sufficient for most of his needs, albeit if he wishes to read such highly mathematical works as Gibbs's papers he must purque his studies somewhat further. For the class for whom it is designed the book is far more useful than the ordinary text on calculus.

Edwin Bidwell Wilson
Massachusetts Institute of Technology

Allgemeine Biologie. Vierte umgearbeitete und erweitete Auflage. Von Oscar Hertwig. Jena, Gustav Fischer. 1912. Pp. 787, mit 478, teils farbigen, Abbildungen im Text.

The appearance of a fourth edition of this

standard work so soon after the publication of the third (1909) is convincing evidence of its usefulness. Indeed there is no other recent work which deals with such a wealth of material of general biological significance; and there are few biologists who possess Professor Hertwig's facility for clear and forcible presentation. The book is thoroughly readable. Each edition has been an improvement over the preceding, and the present is no exception, through elimination in a few places, but mainly by the addition of entire new sections, and by incorporation of later results in many places throughout. Thus the new matter of the present edition includes the action of β and γ rays on animal and plant tissues, results of tissue culture methods, and the subject of sex-determination. The subjects of chondriosomes, chemotherapy, dimorphism of spermatozoa, heterochromosomes, graft hybrids, hormones, secondary sexual characters and inheritance of acquired characters have been thoroughly revised and brought up to date. These additions and revisions are those noted in the preface, but the revision runs pretty well through the book.

A great merit of the book is that the author, though zoologist, by no means limits himself to animals in the discussion of biological principles, but makes free use of botanical results throughout. His botanical illustrations are often very illuminative, and the constant combination of animal and plant material serves to emphasize the conception of general biology as treatment of the phenomena of life common to animals and plants.

Professor Hertwig still opposes the prevalent view that the problems of biology are fundamentally problems of physics and chemistry. Even if we were to assume, he asserts, that at some remote time the science of chemistry should be so developed as to reveal the structure of all possible albuminous molecules and their derivatives, and that it provided methods by means of which we could ascertain what kinds of albumen and other organic molecules were present in the cell and in what quantities, we should not thereby gain insight into the essence of the living cell and of protoplasm. And why? Because the cell is not "living albumen," as has sometimes been said, or a mixture of innumerable albuminous molecules, but an organism composed of determinately arranged vital units, which are again complexes of albuminous molecules and therefore endowed with properties as different from the properties of the simple albumen molecule as the latter from the constituent atoms.

It is perhaps presumptuous, even in so seasoned and honored a veteran as Professor Hertwig, to venture to lay down the limitations of chemical research with reference to biology, and the bounds of the insight that future advance may yield into biological problems, for a reason that will appeal only to those biologists who still use "vital units" in thinking and conceive they know their properties. In any event, such a point of view has its obvious limitations, and they are felt in the treatment of many subjects in the book. On the other hand, this exclusively biological attitude is often of the greatest value in the criticism of premature or narrow generalizations of bio-chemists; and in several places Professor Hertwig's broad outlook on the biological field more than compensates for underestimation of the chemical side.

The treatment of a few subjects still remains rather antiquated. For instance, in the chapter entitled "Untersuchungen der einzelnen Reizarten" there is not a single citation more recent than 1891. And in this connection it is surely a serious defect in a work on general biology that the field of animal behavior should be entirely neglected. Another illustration of antiquated treatment occurs in the discussion concerning "Befruchtungsbedürftigtkeit der Zellen," where the whole discussion, so far as infusoria are concerned, is based on Maupas' work, while the more recent work of Calkins, Woodruff and Jennings, is not even cited. But in most subjects such neglect of recent work is not so obvious, though piety towards pioneers is always observed, as is fitting.

The theoretical foundation of the whole treatment remains as before; if it is sometimes unduly prominent, or even, as it seems to the

reviewer, strained in many places, it nevertheless has an important function in the arrangement of material, and inherent interest of its own as the matured expression of opinion of one of the makers of modern biology; but one can not say that it has promise as a working program; it represents the biological conceptions of the nineteenth rather than of the twentieth century.

The book is full of interest, and may be profitably consulted by working biologists of all grades and laymen alike.

F. R. L.

Chemical Phenomena in Life. By FREDERICK CZAPEK, M.D., Ph.D., Professor of Plant Physiology in the University of Prague. New York and London, Harper and Brothers. 1911. Pp. ix + 151.

We have before us bearing the above title an extremely interesting and valuable little book included in Harper's "Library of Living Thought." This book should prove to be of great interest to all those interested in the chemistry of life. And I take it that there are no students to-day interested in biology who are not insensibly drawn into the consideration of those varied chemical phenomena so highly characteristic of living things. To the botanist who is familiar with Czapek's "Biochemie der Pflanzen" in the German this little book (really a condensation of that great work) comes with particular interest. It was indeed a most difficult task, as the author admits, when it was attempted to put in condensed and rather *popular* form the subject matter with which he has busied himself for so many years. But it seems that this has been accomplished in a most admirable manner. However, it must not be supposed that this little volume is easy to read and understand; it is far from being adapted to the beginner in biology. The author states in the preface that "a *fair* knowledge of physics and chemistry, both organic and physical, is required, besides the great number of biological facts which must be remembered when we try to obtain a satisfactory survey of the general physiology of the plant." Consequently this book will be of most value to those who have had a university training which included the above requirements.

With Czapek's well-known contributions to this field of botany all that is necessary to do to portray the value and scope of this book is to indicate the chapter heads as follows: Biology and Chemistry; Protoplasm and Its Chemical Properties; Protoplasm and Colloidchemistry; the Outer Protoplasmatic Membrane and Its Chemical Functions; Chemical Phenomena in Cytoplasm and Nucleus of Living Cells; Chemical Reactions in Living Cells; Velocity of Reactions in Living Cells; Catalysis and the Enzymes; Chemical Actions on Protoplasm and its Counter-actions; Chemical Adaptation and Inheritance.

Certainly every student of botany should have a copy of this book, and should read it again and again, not only for the considerable amount of subject matter here precipitated from a mass of bewildering details, but also because of the broadening of the point of view that is certain to result from its careful study.

RAYMOND J. POOL

THE UNIVERSITY OF NEBRASKA

STANDARDIZATION OF THE ACCOUNTS OF LEARNED SOCIETIES

THE United States is now supporting somewhere between 100 and 200 societies of which the object is the extension of learning, the promotion of science and common action in some field of intellectual endeavor. In a country so rich and so generous as the United States, it is not difficult to obtain support for such enterprises, and new ones are added every year. Still many of them find it hard to make both ends meet; a few are able to accumulate a permanent fund.

The accounts of these societies are almost all reported, and in most cases printed, every year; and it might be supposed that institutions founded for the inculcation of truth, exactness and efficiency would give to their supporters a detailed, analytic statement of receipts and expenditures. This is, however, far from being the case. The accounts of the societies are in general brief and far from self-

explanatory. An illustration of the methods of some of the societies, and a test of their thoroughness in keeping accounts is the annual statement for the last year available when this article was prepared, for each of four large and active national societies in kindred fields: namely, The American Academy of Political and Social Science, the American Economic Association, the American Historical Association and the American Political Science Association. Following are the reports of these four societies:

THE AMERICAN ACADEMY OF POLITICAL AND SOCIAL SCIENCE

SUMMARY OF INCOME AND EXPENDITURES FOR THE YEAR ENDED DECEMBER 31, 1910

Cash on hand January 1, 1910		$7,745.38
Income		
Annual membership fees	$22,610.16	
Life memberships	709.64	
Special contributions	1,510.00	
Subscriptions to publications and sales thereof	8,274.70	
Income from investments	2,361.91	
Income from bonds matured	4,500.00	
Interest on deposits	139.02	
		40,105.43
		$47,850.81

Expenditures

Clerical services	$6,008.18		
Printing stationery and postage in connection with publication of *Annals* and with general correspondence	19,269.82		
Office expenses	2,851.01		
Expenses of meetings	2,243.74		
Profit and loss	5.00		
Investments purchased $12,975.00			
Interest, premiums and commissions on above purchases ... 266.56			
	$13,241.56		
			43,619.31
Balance, December 31, 1910			$4,231.50
Distributed as follows:			
Mortgage Trust Co. of Penna.	$3,807.50		
Centennial National Bank	200.00		
With A. S. Harvey	134.65		
With E. Tornquist	100.00		
	$4,242.15		
Less overdraft Academy Office	10.65		
			$4,231.50

REPORT OF THE TREASURER TO THE AMERICAN ECONOMIC ASSOCIATION FOR THE YEAR ENDING DECEMBER 20, 1911

I. BALANCE SHEET

Resources		*Liabilities*	
Investment	$1,000.00	Bills payable	$1,000.00
Cash on hand	390.03	Accounts payable	1,003.60
Stationery on hand	50.00	Membership dues (prepaid)	674.82
Insurance (unexpired)	32.00	Guarantee fund (prepaid)	260.00
Furniture and fixtures Sec.-Treas. Office	162.00	Annual meeting (luncheon tickets purchased in advance)	331.65
Dues receivable	492.00		
Accounts receivable	155.00		
	$2,281.03		
Deficit	989.04		
	$3,270.07		$3,270.07

II. INCOME ACCOUNT

Expenses			*Receipts*	
Quarterly printing	$385.81		Dues	$5,621.95
Economic Bulletin editorial	187.32		Subscriptions	842.26
Economic Bulletin printing	475.33		Sales of publications	860.64
		$1,047.96	Interest	100.52
Proceedings and *Handbook*		1,423.86	Guarantee fund	2,309.07
Amer. Econ. Review printing	2,495.18			
Amer. Econ. Review editorial and manuscript	2,956.40			$9,734.44
Editors' expenses and supplies	1,279.01			
		6,730.59		
Secretary's Office:				
Office salaries	1,583.73			
Traveling expenses	85.45			
Stationery, including office printing	223.50			
Office postage	440.15			
Office supplies	162.71			
Telegraph and telephone	26.37			
Express, freight and cartage	14.50			
Miscellaneous	27.98			
		2,564.39		
Rent (storage of stock)		91.67		
Insurance		33.08		
Annual meeting		216.05	Deficit for the year	2,373.16
		$12,107.60		$12,107.60

III. SURPLUS ACCOUNT

Deficit for year	$2,373.16	Surplus at beginning of year	$1,242.12
		Supplies as per inventory at beginning of year	142.00
			1,384.12
		Deficit balance at end of year	989.04
	$2,373.16		$2,373.16

THE AMERICAN HISTORICAL ASSOCIATION

REPORT OF CLARENCE W. BOWEN, *Treasurer*

Receipts

Dec. 19, 1910			
Balance cash on hand			$4,741.64
Dec. 18, 1911			
Receipts as follows:			
2,569 ⅔ annual dues at	$3.00	$7,709.00	
1 annual dues at		2.99	
1 annual dues at		3.02	
7 annual dues at	$3.05	21.35	
23 annual dues at	3.10	71.30	
3 annual dues at	3.15	9.45	
4 life memberships at	50.00	200.00	
Sales of publications		532.00	
Royalties		133.41	
Interest on bond and mortgage		850.00	
Dividends on bank stock		200.00	
Sales of waste paper		7.67	
Loan, National Park Bank		1,500.00	
			11,240.19
			$15,981.83

Disbursements

Dec. 18, 1911

Treasurer's clerk hire, vouchers 16, 67, 70, 124, 136, 142	$388.00
Secretary's clerk hire, vouchers 17, 46, 52, 56, 58, 65, 74, 75, 88, 100, 109, 116, 127, 140, 141, 154, 156 ..	797.40
Postage and stationery, Treasurer and Secretary, vouchers 13, 18, 24, 25, 31, 44, 47, 54, 55, 63, 66, 69, 76, 86, 89, 98, 99, 104, 105, 107, 108, 111, 115, 119, 128, 130, 133, 137, 145, 147, 155, 158, 161	378.07
Secretary of the council, vouchers 4, 34, 40, 83, 84, 126, 148, 149, 150, 176, 177	70.54
Pacific Coast Branch, vouchers 79, 80	26.73
American Historical Review, vouchers 38, 43, 49, 60, 71, 72, 82, 96, 113, 121, 146 ..	4,532.00
Public Archives Commission, vouchers 30, 33, 42, 51, 85, 131, 151, 172, 178, 179 ...	370.55
Historical Manuscripts Commission, voucher 68	30.00
Committee on the Justin Winsor Prize, voucher 22	200.00
Committee on Bibliography, voucher 103	50.00
Committee on a Bibliography of American Travels, voucher 153	15.00
Committee on a Bibliography of Modern English History, vouchers 6, 41, 125 .	56.50
Committee on the Certification of Teachers, vouchers 134, 135, 160, 163, 164 ...	28.93
Committee of Five on the Teaching of History in Secondary Schools, voucher 50	5.00
Committee on Historical Sites, vouchers 7, 8, 9, 10	49.05
Committee on Indexing the Papers and Proceedings of the Association, vouchers 62, 81	150.00
Committee on Writings on American History, voucher 39	200.00
Conference of Historical Societies	15.75
General Committee, vouchers 11, 12, 15, 93, 168, 181 ..	200.19
Publication Committee, vouchers 28, 29, 35, 117	32.74
Annual Report for 1908, vouchers 90, 91, 94, 102, 122, 123, 139	129.35
Annual Report, 1909, vouchers 106, 138, 182	52.40
Handbook, 1911, vouchers 26, 57, 61, 97, 118	494.43
Executive Council expenses, vouchers 5, 27, 152, 162, 165, 166, 167, 170, 171, 173, 174, 180	2.8(
Editorial work, vouchers 19, 48, 53, 64, 73, 87, 101, 112, 114, 129, 144, 157	300.00
Furnishing Secretary's Office, voucher 78	321.52
Expenses Twenty-sixth Annual Meeting, vouchers 1, 2, 3, 20, 21, 36, 37	116.15
Expenses Twenty-seventh Annual Meeting, voucher 159	1.70
Bank stock, voucher 32	2,160.00
Collection charges, vouchers 59, 92, 110, 132, 175, 183 .	11.20
Miscellaneous expenses, vouchers 14, 23, 45, 77, 95, 120, 143	1,545.40

	$12,731.40
Balance cash on hand in National Park Bank	3,250.43
	$15,981.83

Net receipts 1911	$ 9,740.19
Net disbursements 1911	11,231.40
Excess of disbursements over receipts	$ 1,491.21

The assets of the Association are:

Bond and mortgage on real estate at No. 24 East 95th St., New York	$20,000.00	
Accrued interest from Sept. 29, 1911, to date	188.89	
20 shares American Exchange National Bank stock at $250	5,000.00	
Cash on hand in National Park Bank	3,250.43	
		$28,439.32
An increase during the year of ...		$921.43

New York, December 18, 1911

THE AMERICAN POLITICAL SCIENCE ASSOCIATION
REPORT OF THE TREASURER FOR THE YEAR 1911

Receipts

Balance on hand December 22, 1910 ..	$ 7.30
Annual dues	3,770.00
Life memberships	150.00
Subscriptions	231.00
Publications sold	474.74
	$4,633.04

Expenditures Aggregated

Legislative notes for *Review*	$ 100.00
Clerical assistance to Secretary and Treasurer	465.00
Printing, stationery and mailing	3,060.85
Expressage on *Proceedings*	167.24
Postage and office expenses of Secretary and Treasurer	343.41
Payment on loan	400.00
Miscellaneous	74.40
Total expenditures	$4,610.90
Balance on hand December 22, 1911 .	22.14
	$4,633.04

The methods of these societies are so different, and the direction of their outgoes so varied, that no comparison is possible without an analysis and restatement of the accounts, as below.

These tables require some explanation: in the first place there is a difference in every case between the number of paying members (found by dividing the annual receipts from members' dues by the annual fee), and the recorded number of members. In societies gaining rapidly in numbers they will never be the same, but where the difference is so great as appears in the Academy, viz., 945, the presumption is that a lot of paper members are being carried on the rolls.

The cash receipts are a function of two variables, the number of members and the annual fee: the Academy charges $5 and has

RECEIPTS OF FOUR NATIONAL SOCIETIES
FISCAL YEAR 1910

	Am. Acad. Pol. and Soc. Sci.	Am. Econ. Assoc.	Am. Hist. Assoc	Am. Pol. Sci. Assoc.
Memberships:				
Recorded members.....	5,467	1,850	2,925	1,850
Paying members......	4,522	1,814	2,606	1,186
Cash Receipts				
Memberships:				
Annual..............	$22,610	$5,621	$7,817	[illegible]
Life	709	—	200	298
Total...................	$23,319	$5,621	$8,017	[illegible]
II Publications:	8,275			
Subscriptions		842	—	188
Sales		861	532	41
Royalties............		—	133	—
	8,275	1,708	665	597
III. Investments	2,501	101	1,050	—
IV. Contributions.........	1,510	2,309	—	—
Grand total..........	$35,605	$9,734	$9,740	[illegible]
Invested fund and current balance	$58,000	$1,000	$28,440	—

PUBLICATION BILLS OF THE FOUR SOCIETIES (1910)

	Am. Acad. Pol. and Soc. Sci.	Amer. Econ. Assoc.	Am. Hist. Assn.	Am. Pol. Sci. Assn.
Number of paying members	4,522	1,814	2,606	1,186
Proceedings:				
Pages....	....	468	890	[illegible]
Total words.................	....	190,000	332,000	[illegible]
Cost	....	$1,424	....	....
Periodicals:				
Pages.........................	1,523	990	984	[illegible]
Total words................	685,000	380,000	492,000	[illegible]
Prize essay:				
Pages......	....	....	228	....
Total words................	....	....	71,001	....
Total words paid for by societies	685,000	570,000	492,000	346,000
Total expense of printing publications....	$22,278	$9,202	$5,509	[illegible]
Expense per 1,000 words	32.50	10 10	11.20	9.97
Expense of publications.	$22,278	$9,202	$5,504	[illegible]
Receipts from publications	8,275	1,708	656	597
Net expenditures..........	$14,003	$7,494	$4,844	[illegible]
Paid to contributors......	....	1,456	1,500	....
Net publication cost	$14,003	$6,048	$3,344	[illegible]
Net cost per 1,000 words.	20.41	10.60	6 80	[illegible]

EXPENDITURES OF THE FOUR SOCIETIES
FISCAL YEAR 1910

	Am. Acad. Pol. and Soc. Sci.	Am. Econ. Assoc.	Am. Hist. Assn.	Am. Pol.Sci. Assn.
I. Administration:				
Salaries		1,584		
"Office expenses"	2,851	826	1,288	836
Sta., post., tel., etc.			378	
Trav. and cler. ex.		85	324	
Miscellaneous	3,000[1]	125	1,557	96
Total	$5,82	$2,620	$3,542	$982
Per paying memb.	$1. 1	$1.44	$1 85	$0 81
II. Publications:				
Annual report			(Govt)	
Proceedings		1,424	677	800[2]
Periodicals			4,532	2,548[2]
Printing, sta., post.	16,270			
Printing		3,543		
Editorial salaries		1,500	300	100
Contributors		1,456	—	—
Editors' expenses		1,279	—	
Clerical services	6,008			
Total	22,278	9,202	5,509	3,448
Per paying memb.	$4.98	$5.07	$2 11	$3.03
III. Activities:				
Meetings	2,244	216	118	—
Coms. of investgn.			1,408	
Total	2,244	216	1,521	—
Per paying memb.	$ 49	$ 11	$.58	—
Grand total	30,378	12,038	10,572	4,880
Per paying memb.	$6.71	$6 63	$4.05	$3.84

[1] Total $19,270; analyzed into items by guess.
[2] Total 3,348; analyzed into two items by guess.

nearly twice as many members as any of the other associations. None of the societies apparently makes a practise of soliciting life memberships.

The income from publications also varies, the Academy alone of the four societies having a notable sale for its publications outside its own members. The accounts of that society do not make a distinction between outside subscriptions and the sales of numbers to members of the society.

The Academy and the American Historical Association both have invested funds which add considerably to the income.

The Academy and the Economic Association in the year under review received considerable sums as contributions outright or as guarantees for some special enterprise.

The income of the societies varies from $3,600 to $40,000 a year. Those incomes, whatever their derivation or their source, should be considered as trusts to be administered for the benefit of the field of investigation and study represented by the society. All four of the societies have systems of regular publications which, in order to furnish a basis of comparison, have been calculated according to the number of thousand words. The *Annual Report* of the American Historical Association is printed by the federal government, which much relieves its budget. Each of the societies maintains a periodical—that of the Academy considerably the most voluminous. The Historical Association also publishes a prize essay, which however pays for itself out of sales.

It is difficult to ascertain from the accounts precisely how much these publications cost; but by a careful study and aggregation of items, it appears that the Academy pays $32.50 per 1,000 words, as against an average of about $10.50 by the other three associations. The edition of the *Annals* of the academy is larger—perhaps twice as large—as any of the other three societies, but anybody knows that when plates are once made, the expense of running off additional copies is a comparatively small matter. On the other hand, the Academy's cost of publication is relieved by about $8,000 of receipts. Here again the comparison is confused because the economic and historical periodicals pay contributors. Making allowance for those items it would appear that the net cost per words for the Academy is from two to three times that of the two sister societies.

In all the societies the publication forms one of three principal groups of expenditure. The Academy lumps under the head of "Printing, stationery and postage in connection with publication of *Annals* and with general correspondence, $19,269.82." It is absolutely impossible from these figures to subdivide between general administration and publication; and therefore $3,000 is by guess assigned to administration out of the total sum. On the basis of the paying members, the administration per member is about the same, but of course it ought to be distinctly less per capita for the larger society. The same remark applies to the per capita cost for publications: one of the advantages of a large membership is that it should reduce all print-

ing and administration costs. All of the societies maintain some sort of public activity. The Historical Association, and (since the date of this report), the Political Association, have moved in the same direction.

The net expenditure varies from $30,000 for the Academy to $4,000 for the Political Science Association. The measure of the effectiveness of these societies is however not the sums spent but the value of the work done. The Academy, with $30,000 a year to spend, ought certainly to be lending a far greater aid to the problems of the general subject of history, government and economics than the three other societies with their combined income of $27,000. How far that is the case must be left to the decision of those cognizant of the work of the four societies. One thing is certain, that none of the four societies furnishes a sufficiently detailed account; and that the report of the American Academy of Political and Social Science shows over $20,000 a year expended for publications as against $18,000 for the publications of the other three societies. The published accounts do not furnish a basis from which it is possible to find out why its cost per unit for carrying on and printing the publication should be twice as great as those of all the three sister societies doing the same kind of work. Here is an opportunity for a reform in corporate accounts.

Albert Bushnell Hart
Harvard University

SPECIAL ARTICLES

EVIDENCE THAT SODIUM BELONGS TO A RADIOACTIVE SERIES OF ELEMENTS

By the usual test for radioactivity, *i. e.*, the continued ionization of a gas independent of other physical conditions, sodium as an element does not display any activity that is definitely greater than that found in all matter. And the ionizing activity of ordinary matter is so slight that it can not be stated with definiteness whether or not it is of itself radioactive. But radioactivity implies a more fundamental change than that of emitting matter and energy continuously. It implies an atomic disintegration. If α particles are emitted the atoms go by leaps and bounds to new atoms of other properties, while if β and γ radiations are emitted the wearing away of the atoms must be just as certain, though no one has been able to conjecture by what steps the change might take place.

Campbell and Wood[1] examined the sodium compounds for ionizing radiations. Their apparatus would have detected an activity much less than that of potassium, which is only one thousandth that of uranium. No radiations could be measured. The fact that a given element does not give out a measurable ionizing radiation is not necessarily evidence that it is not radioactive. For example, we may note the case of radium *D*, which gives no measurable radiations. Yet it disintegrates to half value in about forty years. It is therefore known as a radioactive element. Further, helium as an element may be classed as a radioactive element, providing all helium is of radioactive origin, although of itself no ionizing radiations are emitted. It is sufficient that an element be of radioactive parentage. Thus sodium is a radioactive element if it can be shown that it disintegrates into other forms of matter or if it is the result of the disintegration of other forms of matter.

If sodium is a radioactive element we may at present look for other evidence than direct radiations. We shall inquire if in past geologic time sodium has accumulated radioactivity from other matter, or, on the other hand, if sodium has disappeared or disintegrated into other forms of matter.

THE EVIDENCE FROM GEOLOGY

Geophysics furnishes two distinct lines of evidence which favor the hypothesis that sodium belongs to a series of radioactive elements. The first is based on the age of the earth as determined by radioactive data and by the accumulation of sodium in the ocean. The second is based on the relative accumulation in the ocean of sodium compared to chlorine, taken in connection with the relative

[1] *Proc. Camb. Phil. Soc.*, 14, p. 15.

annual output of these two elements by the rivers.

Different authorities give the age to range between seventy and one hundred million years. On the other hand, the data of radioactivity require the age to be about ten times as great as the figures above noted. The principles of the radioactive method are based on the determination of the amounts of helium or lead associated with known quantities of uranium found in rocks of different epochs. The two principal assumptions that are involved are that during the age in question the amount of the uranium and its products which give rise to helium shall have remained constant and that the rate of production of helium shall have remained unchanged. Naturally these two assumptions can not be proved. It can only be said that there is no evidence that casts much suspicion on these. However, in all determinations by the radioactive method some error may accrue owing to a simultaneous deposition of uranium and lead and helium at the time of formation of the rock whose age is in question. As may seem clear later in this discussion, the magnitude of this error is probably not greater than the discrepancy between the age as determined by the accumulation of helium and by the accumulation of lead.

According to experiments by Rutherford and his colleagues one gram of uranium in equilibrium with its products gives 10.7×10^{-8} c.c. of helium per year. Now if we examine the rocks of the different geological epochs we find the rare gas helium enclosed in the rock wherever uranium is found, and further the older the rocks the greater is the amount of the helium associated with each gram of the uranium. Obviously, if we divide the total amount of helium per gram of uranium by the above constant, 10.7×10^{-8}, we obtain the number of years during which the uranium has been depositing helium, *i. e.*, the age of the rock containing the uranium. It may be mentioned that the diminution of the amount of uranium during the age in question is so small that it may be considered negligible in comparison with other errors.

Perhaps the greatest chance for error in the above method of calculation lies in the possible escape of helium from the rock containing the uranium. If so the age of the rock as calculated might be too small. The method would therefore set a minimum limit on the age of the earth.

But if we accept Boltwood's conclusion that the lead associated with uranium in rocks resulted from the radio-active disintegration of the uranium series of elements, and that one gram of uranium gives rise to 1.88×10^{-11} gram of lead per year, we have a check upon the results obtained based on the helium deposits. In general the lead deposits give a somewhat larger age for a given rock than do the helium deposits, which is what we should expect if the helium may escape or if lead might have been deposited with the uranium originally.

Using the method outlined above, Rutherford, in 1906, found the age of a sample of fergusonite to be 240,000,000 years. This was deduced as outlined from the fact that 1.81 c.c. of helium was taken from one gram of the mineral known to contain about 7 per cent. uranium.

Strutt by the same method found two rocks of the Archæan period from Quebec to be 222 and 715 million years old, and two of the same kind from Norway to be 213 and 449 million years old. He also found the average minimum value for hæmatite of the Eocene period to be 31 million years, the same for the carboniferous period limestone to be 150 million, while for the Archæan age the average was 710 million years.

Holmes[2] using as a basis the ratio of the lead to the uranium in the rocks found the values given in the following table:

Period	Age
Carboniferous	340,000,000 years.
Devonian	370,000,000.
Pre-Carboniferous ..	410,000,000.
Silurian	430,000,000.
Pre-Cambrian ...	1,025,000,000 Sweden. 1,310,000,000 U. S. 1,640,000,000 Ceylon.

[2] *Roy. Soc. Proc.*, Ser. *A*, 85, p. 248, 1911.

The above results show that the earth in its present form must be many times a hundred million years old.

However, if we take the evidence as based on the result that is obtained by dividing the total amount of sodium in the ocean by the annual additions of all the rivers of the globe, we find that the age of the ocean can not be more than one hundred million years. Two of the most eminent geologists, F. W. Clarke[3] and J. Joly,[4] think 70,000,000 years to be more nearly the correct age. It seems to me that those estimations were not made without due consideration of the largest sources of error. According to Clarke the saline matter of the ocean if segregated would occupy nearly five million cubic miles, a quantity compared to which all beds of rock salt become insignificant. He also considered the salt of marine origin in sedimentary rocks and he figured that a correction of not more than one per cent. was necessary to allow for sodium disseminated in this way. If there is error due to unequal annual additions by the rivers, Becker[5] argues that it is altogether in favor of making the age of the earth yet smaller rather than larger, perhaps between 50 and 70 million years. There is therefore a discrepancy between the age of the earth as deduced by the two methods. Joly in the *Philosophical Magazine* for September, 1911, favors the view that the radioactive constants are in error, because these constants have not been taken from data extending over a sufficiently long time and under proper circumstances free from doubtful assumptions.

I wish to suggest that there is another explanation of the discrepancy that requires no distrust of the radioactive constants as they have been experimentally determined. In fact, the explanation is merely an extension of our knowledge in radioactivity. The discrepancy may be made to disappear if sodium is supposed to belong to a series of radioactive elements. If we accept the present data of radioactivity as authoritative, then it must be admitted that there is not enough sodium in the ocean. Perhaps during geologic time elements of higher atomic weight may have been disintegrating into sodium, and therefore the annual output of the rivers now is not the same as the average annual output for all time in the past. That is, the sodium over the land has been increasing by radioactive production while sodium in the ocean has been increasing almost entirely by the annual river supply. This would necessitate that the parent of sodium should commonly exist in relatively insoluble compounds. Otherwise we should have had sodium produced radioactively also in the ocean, and perhaps sodium deposits in the bottom of the ocean. The above fact should give us some clue as to the parentage of sodium, if our whole argument is not faulty. Obviously those elements that have been deposited in the ocean bed in appreciable quantities are eliminated.

The second way for explaining the small sodium content of the ocean is to assume that the sodium in the ocean has disintegrated into other elements. The theory of radioactivity as it now stands, however, requires that the rate of decay of an element shall not be altered by its physical state or surroundings. Then it is highly probable that the sodium in the ocean has not decayed faster than has the sodium on the land, and therefore any diminished quantity of sodium on the ocean would have been offset by a diminished annual addition of the rivers. But the quantity of sodium carried by the rivers is not known to vary greatly with the amount in the earth's crust. It seems then that this second explanation is within the limits of possibility.

The simplest explanation and one which requires no apologies or additional assumptions is based on the supposition that the sodium on the land has been increasing by virtue of the existence of the parent of sodium there and the non-existence of the parent in the ocean or the ocean bed. Perhaps there would be less chance for error if it were stated that the pres-

[3] Bulletin 491, U. S. Geol. Surv.

[4] *Phil. Mag.*, Ser. 6, 22, p. 357, 1911.

[5] *Quart. Journ. Sci.*, May, 1909.

ence of sodium must have existed more abundantly on the land. This is along the lines of recent progress, and it is particularly favored because it is the only apparently reasonable explanation for another discrepancy arising from the facts of geochemistry. This additional discrepancy is involved in the succeeding paragraphs.

FURTHER EVIDENCE FROM GEOLOGY INDICATING THAT SODIUM BELONGS TO A SERIES OF RADIOACTIVE ELEMENTS

There are other elements carried to the ocean by the rivers in a soluble state, which indicate quite a different age of the earth, and consequently favor the radioactivity of sodium. Only those elements that are not deposited in the ocean bed or otherwise removed from the ocean water may be considered for reliable information. Clarke in his "Geochemistry," second edition, p. 125, gives the following facts; the figures in the last column are my own deductions however.

	Annual Output from Rivers, Metric Tons	Metric Tons in the Ocean	Age of the Ocean
Chlorine ...	$155,350\times10^3$	$25,536\times10^{12}$	160×10^6
Sodium......	$158,357\times10^3$	$14,136\times10^{12}$	89×10^6

The geologists do not believe that the rivers carried any less chlorine or sodium formerly than they do now. In fact, Becker thinks that they must have carried more previously than they do now. But supposing they did carry less sodium in previous ages (in order to explain away the discrepancies on the age of the earth), there is no obvious reason why they should not also have carried proportionately less chlorine. We may, therefore, for checking purposes, say nothing concerning the annual river output further than it should have varied alike with sodium and chlorine. On this assumption the above figures show that there is not as much sodium in the ocean as there should be. Disregarding the radioactivity data for the uranium series of elements altogether, we see that the above evidence favors radioactivity of sodium. Clarke goes on further to state:

> We can understand the accumulation of sodium in the ocean and some of the losses are accounted for, but the great excess of chlorine in sea water is not easily explained. In average sea water sodium is largely in excess of chlorine; in the ocean the opposite is true, and we can not help asking whence the halogen element was derived. Here we enter the field of speculation and the evidence upon which we can base an opinion is scanty indeed.

This excess of chlorine can be accounted for by the same hypothesis that was used to explain the discrepancies in the age of the earth in the early part of the paper, viz., sodium has either accumulated radioactively on the land or disintegrated in the ocean, while for chlorine either these changes have not taken place or else they have gone on at a rate much slower than that in sodium.

From the foregoing, it is obvious that, whether we consider the radioactive data or only the data of geochemistry, either method of approach makes it convenient to assume that sodium belongs to a radioactive series of elements. There has not been to my knowledge any satisfactory explanation for the discrepancies to which attention is called in this paper, either singly or in common. However, it may be noted that the age of the earth as calculated from the chlorine content of the ocean is yet much smaller than that given by the radioactive data, but I do not believe this to be seriously against the argument as presented. It may be that chlorine is accumulating slower than sodium on the land, or perhaps all matter is radioactive in varying degrees, but that is beyond the argument here presented.

It seems worth while to inquire further what elements of atomic weight greater than that of sodium are found more abundantly on land than in the ocean. If our hypothesis is correct we might obtain a list of elements one or more of which should give rise to sodium. And a further study of this list, both in nature and in the laboratory, might reveal the parent of sodium. Of course if the parent of sodium had long ago become extinct this search would be futile.

F. C. BROWN

STATE UNIVERSITY OF IOWA

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE SECTION A—MATHEMATICS AND ASTRONOMY

As both mathematics and astronomy were represented by national societies meeting in affiliation with the association, Section A confined itself to an afternoon session, which was held on Tuesday, December 31. Professor E. B. Van Vleck, of Wisconsin University, presided during this joint meeting of Sections A and B, the American Mathematical Society (including the Chicago Section), the American Physical Society and the Astronomical and Astrophysical Society of America. The meeting was attended by more than two hundred and fifty members of the association and affiliated societies.

In the absence of the retiring vice-president and chairman of Section A, Professor E. B. Frost, director of Yerkes Observatory, his address, entitled "The spectroscopic determination of stellar velocities, considered practically," was read by Professor J. A. Parkhurst. This address will be published in *Popular Astronomy*. The retiring vice-president and chairman of Section B, Professor R. A. Millikan, University of Chicago, presented an address entitled "On unitary theories in physics," which will appear in SCIENCE.

In addition to these two addresses the following four papers were presented during the session of Section A:

"Henri Poincaré as a mathematical physicist," Professor A. G. Webster, Clark University.

"Some general aspects of modern geometry," Professor E. J. Wilczynski, University of Chicago.

"Cosmical magnetic fields," Dr. L. A. Bauer, director of the Department of Terrestrial Magnetism, Carnegie Institution of Washington.

"Preliminary note on an attempt to detect the general magnetic field of the sun," Professor G. E. Hale, director of Mt. Wilson Observatory.

In the absence of Professor Hale his paper was presented by Dr. Bauer. The others were presented by their respective authors. Professor Webster's paper will appear in SCIENCE. Brief abstracts of the other three are as follows:

After discussing briefly the general relations between analysis and geometry, Professor Wilczynski considered the notion of a space of n-dimensions and showed how wide is the applicability of this idea even if we confine our attention to ordinary space, provided a suitable geometric form is chosen as generating element. His developments culminated in a general theorem which, as he claims, represents a fundamental unifying principle of geometry. This theorem may be stated as follows: The projective geometry of any analytic k-spread in a space of n-dimensions is equivalent to the theory of the invariants and covariants of a certain associated completely integrable system of partial differential equations. The paper will appear in the *Bulletin of the American Mathematical Society*.

Dr. Bauer made application of the results of his investigations on the origin of the earth's magnetic field, presented at the Pittsburgh meeting of the Astronomical and Astrophysical Society of America, and Section B of the association at the Cleveland meeting, to the possible magnetic fields of the sun and planetary bodies. A new mathematical method of analysis of the earth's magnetic field was briefly sketched. The paper will appear in *Terrestrial Magnetism and Atmospheric Electricity*, 1913.

Although some definite results have been obtained by Professor Hale, further observations will be required to prove conclusively whether or not the effects found are due to the sun's magnetic field. However, the present observations indicate that the north and south poles of the sun agree in magnetic polarity with those of the earth. As far as the strength of the field is concerned, a knowledge of the Zeeman effect for the lines in question is necessary to determine this. It happens that all of these lines are too faint in the spark to appear on the photographs, but another effort is being made to observe their behavior in the magnetic field.

The investigation is being pushed forward as rapidly as possible, in view of the quiet condition of the sun, since the appearance of sunspots, with their very powerful magnetic fields, will tend to introduce troublesome perturbations. The paper appeared in *Terrestrial Magnetism and Atmospheric Electricity*, Vol. XVII.

The following members of Section A were elected as fellows of the association: S. B. Barret, Harriet W. Bigelow, A. E. Burton, A. E. Douglass, S. Einarson, F. Ellerman, E. A. Fath, J. C. Hamilton, E. S. Haynes, W. A. Hurwitz, E. S. King, C. O. Lampland, F. P. Leavenworth, O. J. Lee, A. O. Leuschner, J. Lipke, C. P. Olivier, G. H. Peters, W. F. Rigge, D. Rines, E. Smith, T. Stephen, H. T. Stetson.

The section elected Dr. J. A. Brashear member of the council, Professor C. J. Fields member of

the sectional committee for five years and Professor T. F. Focke member of the general committee. On recommendation of the sectional committee Professor Frank Schlesinger, director of the Allegheny Observatory, was elected vice-president and chairman of the section, and Professor F. R. Moulton, University of Chicago, was elected secretary for five years.

G. A. MILLER,
Secretary of Section A

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

A SPECIAL meeting of the society was held December 3, 1912, at 4:30 P.M., in the New Museum Building, Mr. Stetson, the president, in the chair.

Mr. Wm. H. Babcock read a paper on "The Islands of Antillia," illustrated by lantern slide maps, taking the title of his paper from Peter Martyr's "Decades of the New World," where that author, in view of "the cosmographers," states that he believes these islands were what his contemporary, Columbus, had discovered. Peter Martyr's own sketch map of 1511 was exhibited, showing Florida as one of them under the name of Beimeni: also the maps of Beccaria, Bianco, Pareto and Benincasa, from 1435 to 1482, who may be among "the cosmographers" referred to. They show a group of four large islands roughly corresponding in size, arrangement and other respects with Cuba, Jamaica, Florida or Beimeni and Andros of the Bahamas, and bear on Beccaria's map the names Antillia, Reylla, Salvagio and Insula in Mar (Opposite Island or Island out Before, King Island, Savage Island and Island in the Sea). These are nearly as far west of the Azores as the latter are west of Europe and in such a location must be either the creatures of mere fancy or appurtenances of America. But it is not likely that mere guess-work could produce the remarkable correspondences of these great map islands with the reality, such an island group being altogether unique in the Atlantic.

Behaim's globe of 1492 contains an inscription to the effect that a Spanish vessel visited Antillia in 1414, more vaguely endorsed by another on the map of Ruysch (1508) which credits the Spaniards with finding Antillia long ago. That something of the kind happened in the first quarter of the fifteenth century may be inferred from the fact that Beccaria (1535) names the group collectively "The Newly Reported Islands," most likely borrowing this title legend from his earlier map of 1426, although the fourteenth-century maps had contained no suggestion of Antillia and her consorts.

The other fifteenth-century maps named corroborate Beccaria, being very consistent in outline and arrangement so far as they go, although two of them give but three islands and Bianco shows only Antillia and a part of Salvagio, which he calls La Man de Satanaxio, but this last seems to be a case of mutilation. However, the Laon globe of 1493 shows only these two main (rectangular) islands.

A current map showed how naturally any craft entering and continuing in the great-sea-current which sweeps from the Azores and the other eastern islands westward to the Antilles would be carried to Cuba and her neighbors.

The Catalan map of 1375 and the Pizigani map of 1367 with its picture of St. Brandan blessing his Fortunate Islands of Porto Santo and Madeira, and the figures of a dragon and a dentapod, each carrying off a seaman from his ship as a warning against westward exploration, were also exhibited. They show the circular island of Brazil west of Ireland and the more southerly crescent-form Man or Brazir, both being important and persistent legendary islands: and the Catalan map in particular shows all the Azores approximately in their real grouping; but neither of them presents anything like the Islands of Antillia.

Dr. Philip Newton read a paper on the Negritoes of the Philippines, estimating their total number (full bloods) at 5,000, though by counting mixed-blood tribes and individuals the estimate is sometimes carried up to 25,000. They are distributed through numerous islands, though not reported from Mindoro. The greater number are on Luzon. There is no difference in them, except as their blood is mingled with that of neighboring races. They are not fishermen, but hunt and gather natural products, using in some districts poisoned arrows, the symptoms of poisoning being like those of strychnine. Their houses are made of upright poles connected by horizontal poles having cross pieces and leaf thatching. They are buried under or near these homes. They rarely bathe and their clothes (which are breech-clouts or aprons) are apparently never washed. Usually these are of cloth obtained in trade, but in some islands, for example Palawan, bark is used. Negritoes do not regularly practise agriculture, but will sometimes plant rice—and perhaps move away before it ripens. A skin disease is the most

prevalent among them, but malaria also prevails. Three incipient cases of tuberculosis were noted. Some other diseases are derived from their neighbors.

W. H. Babcock,
Secretary

THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

The twelfth regular meeting of the Helminthological Society of Washington was held at Mr. Crawley's residence, November 21, 1912, Mr. Crawley acting as host and chairman.

The secretary presented a paper by Dr. B. H. Ransom entitled "An Important Newly Recognized Parasitic Disease of Sheep." Less than a year ago reports began to come in from inspectors in packing establishments where federal meat inspection is maintained, that a considerable number of sheep were found, on post-mortem inspection, to be infested with tapeworm cysts. These were located in the musculature, and as the infested meat had to be condemned it was a matter of considerable economic importance. German authorities have referred an armed cysticercus in the meat of sheep to *Cysticercus cellulosæ* and it was first thought that this was the case here. But the fact that from one to four per cent. of the sheep killed at some establishments were infested indicates that this was not the case, as *Cysticercus cellulosæ* is very rare in its normal host, the hog, in this country. Microscopic study showed that the form found in sheep was similar to *Cysticercus cellulosæ*, but nevertheless distinct. It seemed further unlikely that the adult tapeworm should be a human tapeworm, as it ought to be reasonably common and to have been recorded before this. The logical host of the adult worm was held to be the dog, and in this connection it may be noted that French investigators of the cysticercus in the meat of sheep have held it to be an aberrant *Cysticercus tenuicollis*, the hooks of the two forms being very similar.

The matter was settled by feeding cysticerci from the meat of sheep to five dogs, and *Cysticercus tenuicollis* to two dogs. All of the dogs developed tapeworms, but those of the five dogs were distinct from those of the two fed *Cysticercus tenuicollis*. Six sheep were then fed tapeworm eggs from the tapeworms of the five dogs, and two were fed eggs of the *Tænia hydatigena* produced in the two dogs from the feedings of *Cysticercus tenuicollis*. One sheep was kept as a check. All sheep fed with eggs from the tapeworms of the five dogs receiving muscle cysts developed cysts in the muscles, but no *Cysticercus tenuicollis;* both sheep fed eggs of *Tænia hydatigena* developed *Cysticercus tenuicollis*, but no cysts in the muscles. The check sheep and other sheep of the same lot had no cysticerci of any sort.

The new cysticercus is a source of considerable loss to the western sheep man and warrants careful prophylactic measures, such as the destruction of the carcasses of dead sheep and the employment of vermifuge treatment for dogs.

Mr. Foster presented a paper entitled "Some Atypical Forms of the Eggs of *Ascaris lumbricoides*." In examining feces or in dissecting ascarids, certain atypical shapes of ascarid eggs are not uncommonly met with. Some of these eggs are very much longer and narrower than the normal eggs, the length, up to 107 micra, being well outside of the limits given in texts. Sometimes nearly all the eggs in an ascarid will be of this sort. Another atypical form has no trace of the usual external mammilated albuminous covering, although segmentation shows that fertilization has occurred. The third form is the unfertilized egg, the unsegmented central embryonic mass filling the entire shell. A recognition of these forms is important in microscopic examination of feces.

The secretary presented a paper by M. C. Hall and J. T. Muir entitled "A Critical Study of a Case of Myiasis due to *Eristalis*." A five-year-old boy in Colorado Springs, Colo., during the summer of 1912, showed a complex of nervous and digestive disturbances, with emaciation due apparently to excessive vomiting. The case was diagnosed as worm infestation. Immediately after defecation following the administration of a vermifuge, an active larva of *Eristalis* was found in the slop jar. A critical examination of the possibility of myiasis due to "rat-tailed larvæ," and of the circumstances in the case discussed, more especially the prompt recovery of the patient, leads the authors to the conclusion that this is probably a genuine case of myiasis. The evidence is more complete and detailed than in any other published case dealing with myiasis due to these larvæ, the other cases being given in detail in the paper. Additional unpublished cases from the U. S. Bureau of Animal Industry and the U. S. Bureau of Entomology were noted. There appear to have been only seven published cases of myiasis credited to "rat-tailed larvæ."

Maurice C. Hall,
Secretary

SCIENCE

FRIDAY, JANUARY 17, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE CHANGE FROM THE OLD TO THE NEW BOTANY IN THE UNITED STATES[1]

IT is generally known that in the seventies there was a sudden development of the study of botany in this country. Just how and why this sudden development took place at that particular date is, I suspect, not clearly recognized, at least by our younger men. From histories and reports of progress they can learn the main facts, but those who, as students or instructors, have lived through the transitional period when the old botany was changed into the new are in a better position to appreciate the underlying causes. There are, however, few such persons still living and the small number is not wholly due to the normal death rate. The relative number of botanists was smaller then than now and it will not do to assume that this was owing solely to the lack of attractions in the botany of the day. The main reason was that one could hardly expect to earn a living as a botanist. When I graduated from college in 1866 and wished to become a botanist, Professor Gray told me that I ought to study medicine first because the possibility of gaining a living by botany was so small that one should always have a regular profession to fall back upon. In fact, at that time medicine was practically the gate through which it was necessary to pass in order to enter the field of botany. Some years later De Bary told me that, when he was a young man, there was a similar state of things in Germany and, although desiring to devote himself to bot-

[1] Address of retiring president of the Botanical Society of America, given at the Botanists' Dinner, Cleveland, January 1, 1913.

any, he had to study medicine, taking his degree in 1853. In 1872, however, things had changed in Europe and when I went to Strassburg to study I was the only student in De Bary's laboratory who had studied medicine. The others had begun the special study of botany on entering the university and were, although no older than I was, much better trained in botany.

In 1866, there were very few botanical professorships in this country, the salaries were very small and the equipment very shabby. Gray was professor at Harvard, D. C. Eaton at Yale and Porter at Lafayette. Torrey, in spite of his distinction as a botanist, really depended on his position as a chemist for his living. The comparatively few positions in government and state stations offered few attractions and changes were frequent. To a young man the prospect was not assuring.

If we look further and ask what was the attitude of the public towards natural science, we find a state of things very difficult to appreciate at the present time. This can be illustrated by my own experience as a school boy. When I was in the high school one of the books we had to study in the upper classes was Paley's "Natural Theology." You may perhaps infer from this that the object was to give us religious instruction. Not at all. The real object was to smuggle a little human anatomy into the schools. This was the way it was done. Very few of you probably ever heard of Paley's "Natural Theology," in its way a remarkable book. In the opening chapter Paley supposes that a man walking in the fields finds a watch on the ground. He sees the complicated machinery adapted to a definite purpose and therefore, according to Paley, at once infers that it must have had an intelligent creator. How much more strongly, therefore, should a contemplation of the organs of the human body, well adapted to perform special functions, lead us to believe in the existence of an intelligent creator. Paley then proceeds to give a rather mild account of human anatomy illustrated by plates intended to impress the readers; a ghastly head with the cheek dissected to show the parotid gland; an abdomen with the lid removed to show the bonbons inside, the stomach and spleen ingeniously arranged so as to show also the deeper lying organs, etc. Paley's reasoning does not now seem altogether convincing. If you or I had found the watch, we should have seen that it was complicated and we should have known that its purpose was to show the time of day. We should have known also that it had been made by a watchmaker. If, however, a savage who had never seen or heard of a watch had found one in the field, he would have been mystified by the mechanism and would not have had the least idea what its purpose was. Instead of recognizing an intelligent creator he would have regarded the watch itself as a god.

Now, at the time of which I am speaking, it would not have been proper to teach anatomy *as such* in the schools, but anatomy, so far as it served to show the goodness and intelligence of the creator, was quite legitimate. In other words in studying natural history one must never forget that God had made man to be the center of the universe and all other things had been arranged for the benefit of man, and, when facts to the contrary appeared, they must be properly interpreted or denied. Since an omniscient and omnipotent being can not make a mistake, all the species of plants created in the beginning must forever remain as they were created. With this simple theory of living things people were perfectly contented until in 1859 the "Origin of Species" fell like a bomb in

the camp and shattered time-worn theories. That the variations and adaptations of plants and animals were not for the benefit of man, but for the benefit of the plants and animals themselves, was a dreadful heresy. The violence of the controversy caused by Darwin's great work was something of which the present generation can have no conception. It was at its height when I was a college student. Young men were generally inclined to accept Darwin's views, and in our college natural history society most of the meetings were spent in discussing evolution. Some of us had really read the "Origin of Species," but all were ready to talk about it. The older men, even the naturalists by profession, were much more conservative. A few adventurous spirits were more Darwinian than Darwin himself, but college professors had to be careful in what they said, for practically the whole religious world and the greater part of college graduates were not ready then to accept evolution. The bitter feeling of the antidarwinians continued for a considerable number of years, as is shown by the following instance. A little more than twelve years after the appearance of the "Origin of Species" one of our leading universities wished to appoint a professor of zoology. The place was offered to a friend of mine with the stipulation that he should never, directly or indirectly, refer to evolution in his lectures. As my friend was one of the most rabid evolutionists in America, the conditional offer seemed amusing. He, of course, declined and the place was then offered to one hardly less radical in his views, and was again declined. It was rumored that the place was offered to a third person and again declined, but I have no direct knowledge that this was the case. The present incumbent, I presume, believes in evolution, but probably no one has ever taken the trouble to ask him whether he does or not for, at the present day we should no more think of asking a professor of zoology whether he believes in evolution than whether he is the fortunate owner of a tooth-brush.

At a time when many of the leading zoologists, including Louis Agassiz, were strongly opposed to Darwin's views, the botanist, Asa Gray, exerted a powerful influence in converting the public to the doctrine of evolution. His simple and attractive style enabled him to reach an audience which would have been repelled by the dryness generally supposed to be characteristic of scientific writings. He was also known to be a member of the orthodox church and the good religious people of the country said: if the orthodox Gray sees in evolution nothing inconsistent with revelation, why may we not also accept it? Furthermore, Gray did not go too far in his views, whereas some of the evolutionists started off on a wild sea of speculation whither the public would not be expected to follow.

Having tried as far as the limited time allows to give you an idea of the attitude of the public towards natural science, at the time when I began the study of botany, a word may be said about the botanical instruction in colleges. At Harvard botany was a required study for the whole class during half of the sophomore year. The text-book was Gray's "Structural Botany." Gray had no assistant. To require botany of a whole college class—I am not speaking of agricultural schools—is enough to condemn it to neglect and abuse. This, however, can be said of college students. If their instructors do not interest them they are always able to amuse themselves. In the corner of our lecture room was the trunk of a palmetto which had been used to grace the funeral procession of Calhoun

and afterwards given by Professor Gibbs to Gray as of historical as well as botanical interest. It was the duty of the athletes while the attention of the instructor was diverted to seize the trunk and carry it to the entry and later on to start it rolling down the very winding staircase. This method of studying botany I discovered later was not confined to Harvard. Once while visiting a western university I noticed, to my surprise, a cannon ball back of a door. I asked why it was there and was told, not by a student, but by the instructor himself, that during the lectures the students rolled it along to the head of the staircase when gravity was left to do its perfect work. Afterwards some attention was paid to the lecturer, and how much was learned on any one day depended on how early in the hour the cannon ball was started on its way. Compulsory botany was not a success. In my junior year eight or ten students who really wished to study botany asked Gray to give them some instruction in systematic botany during the season when fresh material could be obtained. The work on our part was entirely voluntary and in addition to our regular work. It was not recognized by the college and we received no credit for it in the rank list. The number of voluntary workers was reduced to two in my senior year, when we had so much regular work as to leave almost no spare time. I have noticed in recent years a growing disposition to demand some reward in the shape of a degree or a certificate of some kind for any work done outside the regular curriculum. To do work for the pleasure of adding to one's knowledge is, I regret to say, getting to be a sign that one is not up to date.

On graduating I followed Gray's advice and entered the medical school, hoping sooner or later to be able to return to botany. The opportunity came in 1870 when Gray returned from Europe. During his absence Horace Mann, Jr., who had been taking his place, died and I was then appointed assistant. I was always interested in cryptogams and, had it been possible for me to do as I pleased, I should never had studied anything but marine algæ during the rest of my life. It became my duty to arrange the thallophytes of the Gray Herbarium and the work I did was radical, I assure you. Not knowing that Littleton Island was near the North Pole, but supposing it to be somewhere in Long Island, I arranged into the waste-paper basket a number of rather shabby-looking algæ which I afterwards discovered to my mortification were very rare. It did not take long for me to find out that, whatever professors of pedagogy may say, one can not teach a subject without knowing something about it. But where was I to go to study cryptogams? It was proposed that I should study fungi with M. A. Curtis, but he died in 1872. For marine algæ I had to depend on Harvey's "Nereis" and J. G. Agardh's "Species," works which were not easily followed by a beginner, with occasional reference to the by no means exhilarating "Micrographic Dictionary."

Evidently, I must go to Europe, and Germany was the country whose universities offered the greatest facilities for my purpose. The most promising were those of Strassburg, where De Bary was professor, and Wuerzburg, where was Sachs. I chose the former rather at a venture. The other botanists there were Solms and Fr. Schmitz, then a very young man whose work had been in histology. The venerable W. P. Schimper, the bryologist and paleontologist, whose valuable herbarium had been given to the university before the Franco-German war, remained in charge of it and gave a course of lectures. My fellow students were Stahl, Rostafinski,

Gilkinet, Suppanetz, an Austrian, Kamienski, who recently died at Odessa, Karl Lindstedt and Doelbruck, who died young. I learned that I was not the first American who had studied with De Bary. A short time before, while he was professor at Halle, an American, T. D. Biscoe, had taken a course in botany, although not studying botany as a specialty. The only information I have in regard to Mr. Biscoe is that he published a paper on the winter state of our duckweeds in the *American Naturalist* of 1873. There was only one other American, a law student, at Strassburg when I arrived there, for, to the surprise of my fellow-botanists I was not willing to acknowledge as a fellow-countryman a Chilian, whose principal occupation seemed to be duelling and whose English vocabulary was limited to the two words, "damn Yankee."

The general arrangements at Strassburg were the same then as those of other German universities at the present time, but the method of working in the laboratory was very different. I was given a *Chara* to study and in a couple of hours reported that I had studied it. I was told that I had not even begun. Studying, it seems, meant that I must make sections through the scheitel and trace the successive cell-formations. But how was I to make a section and what was a scheitel? The microtome and modern methods of imbedding were then unknown to botanists and all sections had to be made by hand. The nearest approach to imbedding was in sectioning small objects like pollen grains; a few drops of mucilage were placed on a cork, the pollen mixed with it and the whole allowed to harden. Then by holding the cork in one hand one could make sections of the pollen if one were lucky. The student of the present day, when hand-sectioning seems almost a lost art, does not realize what skill in sectioning could be acquired by practise, but, like playing on a musical instrument, constant practise was needed to keep one's hand in. Modern technique, which was borrowed by botanists from the zoologists, has of course many advantages, especially in cytological work, but, for certain work, hand-sectioning has its advantages, as, for instance, the rapidity with which sections can be made.

If I was fortunate in my fellow students at Strassburg, in one respect I was less fortunate. At the time De Bary himself was at work on his "Vergleichende Anatomie," which was published in 1877. Anatomical studies were not his strong point, but, in an unguarded moment, he had promised Hofmeister that he would write the volume for his series and he felt in duty bound to keep his promise. We should have preferred to have had him working on the mycological subjects in which he excelled, but the management of cell cultures and the technique required in such investigations were taught to his pupils. Rostafinski took his doctor's degree while I was in Strassburg, with the thesis, "Versuch eines Systems der Mycetozoen." The monograph of that group did not appear until 1875. I happened to hear De Bary and Schimper talking about Rostafinski's thesis, which they thought was a good work, although they regretted that he had made so many genera. What would they say were they now living, when it almost seems as if we were trying to create a new genus for every species?

In the laboratory I noticed that the students seemed to refer frequently to a book of which I had never seen a copy or even heard. The book was Sachs's "Lehrbuch," second edition, 1870. I bought the book and was perfectly amazed. I had never dreamed that botany covered so large a field. The "Lehrbuch" was an ad-

mirable summary of what was known of all departments of botany up to that date, well written and excellently illustrated. The fourth edition, which appeared while I was in Strassburg, was still better. On looking at the second edition a number of years later, I noticed what seemed to be a curious omission. No mention whatever was made of bacteria. In the fourth edition they are mentioned under *Schizomycetes*. The absence of reference to bacteria in the earlier edition, however, was not an omission. There were no bacteria at that date. There were no bacteria until Cohn published his "Untersuchungen über Bacterien" in 1872. The fact that forty years ago Sachs had never heard of bacteria, while to-day life has almost become a burden, one hears so much about them, is a striking instance of the rapidity of development of a subject having a practical as well as a theoretical value. I know no single book which has had so great an influence in shaping the course of modern botany as Sachs's "Lehrbuch." It may be that the facts there given were generally known in Germany, but they were not known in other countries. On returning home by way of England in 1874, I showed my copy of Sachs to several English botanists and it was evident that it was quite new to them. It was certainly unknown in America. If imitation is the sincerest flattery, the value of Sachs's "Lehrbuch" was quickly recognized, for, using it as a model or basis, there soon appeared a large number of really excellent text-books in various languages in which one recognized Sachs translated, Sachs condensed, Sachs diluted, Sachs trimmed to suit local demands. Publishers, were they capable of gratitude, would have erected a monument to Sachs's memory long ago. Draughtsmen, on the other hand, had little reason to bless his memory. Even now we can hardly open a new text-book without seeing the inevitable "after Sachs."

One evening I was present at a dinner given by De Bary. On that gay and festive occasion I heard more gossip about botanists than one hears even at a meeting of the Botanical Society of America. My neighbors kept saying: "der schmutzige Kerl." On asking who the dirty fellow was, they said Naegeli. In my innocence I inquired what Naegeli they meant. They answered "*Der* Naegeli." Even starch could not save his reputation, and they proceeded to tell not one but many tales which I know you are dying to hear but which I am not going to tell you. What I wish to say is this: At the same dinner some one, possibly Rostafinski, spoke of a certain Strasburger, a botanist. I understood him to refer to some botanist living in Strassburg and asked his name. I was told that he was a Pole named Strasburger who lived not in Strassburg but in Jena and had written a work which showed him to be a promising young man. That was the first time that I had heard of Strasburger, who had not then begun his work in cytology. The promise was fulfilled and the young man of 1873 became one of the bright lights of the botanical world. At the close of his long but too brief career he left a brilliant school in a department of botany which he had created and of which he remained until his death the leading spirit. Fortunately we have with us a younger generation admirably qualified to continue the work which he began.

For the last twenty years most young American botanists have thought it necessary to study in Germany to complete their education, but, when I returned in 1874, I was looked upon very much as one would be who had returned from a journey in Thibet or Central Africa. Things had

changed. The country had recovered from the effects of the civil war, money was more abundant and more could be spent on science. New professors were appointed in the colleges and courses for the instruction of school teachers in botany and zoology were provided by private individuals. I have time only to refer to one curious episode in the development of botany in America. I refer to what may be called the biological epidemic which broke out soon after I returned to America and threatened for a time to drive botany from the field. If at some future time some one ventures to write a book on the abuse of the "ologies" the chapter on biology will be the most interesting. As far as I can make out, as originally used, biology did not differ much from physiology. The laboratory manual of Huxley and Martin was planned to correct the common idea that botany and zoology consisted in the description of different species of plants and animals, whereas in reality they are the study of plants and animals in all their relations to one another and to their surroundings. Huxley and Martin's book was extensively used in this country and was in many ways excellent. The criticism might be made that it was not well proportioned. Without saying that it was all lobster, there was so much lobster and so little of plants that there was not enough to make a good lobster salad. Soon it became the habit of young persons who knew precious little about either plants or animals to call themselves biologists, disdaining to be called botanists or zoologists. It does not follow, however, that because one is neither a botanist nor a zoologist one is to be considered a biologist. Trustees of colleges and similar institutions were given to understand that a superior race of beings had arisen, the biologists, and that botanists and zoologists had had their day. Colleges being always impecunious, this information was gladly received by their governing boards. By calling their zoologists biologists they could escape appointing professors of botany. This clever device for saving a salary worked very well for a few years, but at last it became evident that the teaching by a zoologist with the aid of a text-book, how to distinguish a yeast cell from a fern prothallus and a fern prothallus from a germinating bean, was not all that was wanted in our colleges, although it might have been sufficient in a kindergarten. The epidemic of biology, although it hindered for a time the development of botany in England and America, fortunately never spread to other countries.

Although garrulity is the privilege of old age, I feel that I am still too young to take up more of your time this evening. This occasion, in which the body as well as the soul naturally participates, seemed to me to call not so much for a formal historical account of botany in my day as for a series of personal reminiscences, more or less anecdotical in form, which would throw a little light gained from the experience of one who, although he has lived long, hopes that he has not outlived sympathy with the present, on some of the steps by which our present advanced position among the botanists of the world has been reached. It has been my fortune to see the old order of things overturned by the appearance of the "Origin of Species" which, by freeing science from the fetters of a semitheological bias, opened the way to a free scientific study of the distribution of plants and animals and the great questions of heredity and evolution. To most of you this great change is only a historical fact. To me it is a living memory. I, who was almost the first American student to seek the benefit of botanical instruction abroad,

have lived to see the time when a very large number of our botanists have brought back to America the best that Europe had to offer. There was a time when our botany might have been said to bear the mark "made in England." In more recent years it may be said to have been "made in Germany." There are some patriotic souls who hope that the time will come, if it has not already come, when we may say "made in America." I do not share their feeling. To me it seems that botany is destined to become more and more widely diffused until it becomes world-wide and it will be enough if we contribute our proper share to the general stock. I have lived to see the growth of several branches of botany which practically were not studied at all when I was young. Bacteriology and cytology are of recent origin. Plant physiology has been with us a child of slow growth, but it frequently has been the case that the strongest men have been slow in their development. Plant pathology from a crude and semi-popular beginning has become an exact science in whose study and practical application we have already surpassed other nations. When this society meets forty years hence, I shall not be present. Few of you will be present. But whatever of progress the speaker on that occasion may be able to report will be the result of a gradual development. It can hardly be expected that he will have to record any such radical and complete transformation as it has been my privilege to present to you this evening.

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THE SIMULIUM-PELLAGRA PROBLEM IN ILLINOIS, U. S. A.[1]

The advancement of entomology owes much, of recent years, to the stimulus supplied by the discoveries made by medical men with respect to the agency of insects in the transmission of contagious diseases; and just now our knowledge of the species, distribution, habits, life histories and ecology of *Simulium* is progressing by leaps and bounds in consequence of the well-known *Simulium* theory of the transmission of pellagra, announced by Dr. Louis W. Sambon in 1905, and fully elaborated by him in the *Journal of Tropical Medicine and Hygiene* in 1910.

This stimulus to a study of these insects reached me, in one of the interior states of North America, in August, 1910, when, in consequence of the appointment by the governor of Illinois of a state commission for the investigation of pellagra as occurring in the insane asylums and other institutions of that state, I was requested, as the official entomologist of Illinois, to contribute to their report an account of the distribution of *Simulium*, especially in the neighborhood of state institutions in which cases of pellagra were occurring. As an investigation of all insects injurious or dangerous to the public health in Illinois is one of the prescribed duties of my office, I was bound to avail myself, to the best of my ability, of this opportune call. This I did by detailing an assistant, Mr. C. A. Hart, August 8, 1910, to commence observations and collections along the central part of the course of the Illinois River, and especially to make a careful survey of the vicinity of the general Hospital for the Insane, built upon a bluffy bank of that stream near the city of Peoria. My reason for giving particular attention to this asylum was the fact that it had been the principal seat of pellagra in Illinois, containing in 1909 eighty per cent. of the cases of this disease—that is, one hundred and twenty-seven out of two hundred and twenty—recognized that year in the whole state. This bad preeminence has, in fact, been since maintained, this asylum containing sixty-three per cent. of the four hundred and eight cases known to occur in Illinois during the twenty-six months preceding the first of September, 1911.

[1] Read at the Second International Congress of Entomologists, Oxford, England, August 8, 1912.

In the year 1911 but little could be done on this subject; but beginning with April of the present year a continuous program of observations, collections and breeding-cage studies has been steadily maintained and is still in progress on the Illinois River, and a careful survey has been made of the surroundings of the six insane hospitals of the state, and of the almshouse of the county in which the city of Chicago is situated. Cases of pellagra have occurred in all these institutions during the above-mentioned period, but in widely different ratios to the total number of inmates in each—the Peoria asylum, for example, containing, in 1909, twelve times as many cases per thousand inmates as did any other institution in the state. It thus became a matter of special interest to know the facts in detail concerning the occurrence and abundance of *Simulium* in the immediate neighborhood and in the general vicinity of all these institutions.

Besides this work in the field, the insect collections of my office for many years have been carefully examined, and its field notes and accessions records have been sifted for evidence bearing on the species and distribution of *Simulium* in the state at large; and the whole body of the American literature of the subject has been critically studied, with some reference also to a considerable list of European articles.

According to the present state of our knowledge there are approximately seventy species of *Simulium* on record for the whole world, of which we are known to have but fifteen in the United States of North America. Nine species, or possibly ten—the status of one being uncertain—have been found in Illinois, one of which, *S. hirtipes,* occurs also in Europe. No other European species has been found on the continent of North America, although *S. reptans* is reported from Greenland. The slight attention hitherto paid to these insects in America is illustrated by the fact that two of our nine Illinois species—or three of them, if there are ten in the state—are new to science, descriptions of the two known to be new being now in press, under the names of *venustoides* and *johanniseni*.[3]

As the state of Illinois extends, from north to south, through five and a half degrees of latitude, there is some difference between its most northern and its most southern districts in respect to the predominant species of *Simulium*; but as all have similar habits, and all but one of them are active biters, this fact probably counts for little in the present discussion.

There is some difference also as to the kinds of waters in which the several species prefer to breed, some of them living mainly in the larger rivers, and others occurring only in the smaller streams; but as the state is well watered in all its parts, and is virtually a level plain, there is no part of it which is wholly beyond the reach of some species of *Simulium*. It is true that these insects are rarely seen in some places, and are an annoying nuisance, and indeed a destructive pest in others, especially along the larger rivers in spring; but since we have found them in considerable numbers at a distance of more than five English miles from the nearest water in which they could have bred, and since there is scarcely a small stream anywhere in some part of which *Simulum* larvæ can not be found throughout the spring and summer, even temporary roadside drainage ditches often containing them during the spring season of high water, there must be few people in the state who are not at some time exposed to the attacks of the flies. *Simulium* is, in fact, more completely and uniformly distributed in Illinois than *Anopheles,* and as there is no part of the state wholly and permanently free from malarial disease, there would seem to be no part of it free from danger of pellagra, if this is really transmitted by black-flies.

The contrast is marked between these Illinois conditions and those in Italy, where Sambon and his colleagues studied the problem of pellagra and the distribution of the black-fly.

[3] Since printed in a reprint from the 27th Report of the State Entomologist of Illinois, pp. 32 and 42.

There mountain heights, mountain valleys and level plains make up a diversified topography and hydrography, and the distribution of *Simulium* is similarly diversified. It is one of the main lines of Sambon's argument that the distribution of pellagra is limited by the distribution of *Simulium*, although not coextensive with it. This test can not be verified in Illinois, however, as *Simulium* is generally distributed. Pellagra, on the other hand, is intensely local, so far as is now known; but to this interesting point I shall presently return.

The life histories of the American species of *Simulium* are very imperfectly known, and the same may be said of those of all other parts of the world as well. No species, in fact, has been carefully followed, in its development, around the year, and on only two of our American black-flies, *venustum* and *pictipes*, has any kind of definite life-history work hitherto been done. Probably studies of this sort are now in progress in other places than Illinois, but if so their results have not yet been made known. In our own state we have gone far enough with this phase of our problem to make sure that six of our species, and possibly all of them, produce two or more generations in a season, and that there is a sufficient variation among the different species in respect to the times at which the successive generations emerge, to make it certain that some *Simulium* species may be producing adults at every time of any average year, from early April to late October. We have, in fact, ourselves collected adults of one or more species, and have bred others, in each of these seven months, but much more frequently in April, May and June, than in any later ones.

The actual number of individuals on the wing, indeed, diminishes rapidly after the main spring outburst, so that it is usually difficult to find an adult *Simulium* in August or September, even in places made almost uninhabitable by them in April and May. This may be due in part to unknown features of the life history of two of the most prolific species, *pecuarum* and *meridionale*, but it is certainly due also, at least in part, to summer shrinkage of the streams and a consequent reduction in the number of suitable places for the breeding of these discriminating insects. Whatever is the explanation, the fact itself is notorious, and it is of especial interest to our inquiry; for if *Simulium* transmits pellagra, there should be, generally speaking, some seasonal correspondence observable between this highly unequal abundance of the insect carriers of the disease and the number of new cases occurring.

There is, indeed, a very notable seasonal periodicity shown in Illinois in respect to the number of new cases of pellagra, but it is not of the kind anticipated by this reasoning. My attention was first called to the facts last December by Dr. H. Douglas Singer, director of the State Psychopathic Institute, at Kankakee. In the Peoria hospital, where the largest number of our new cases have occurred, statistical data were obtainable from July 1, 1909, to September 1, 1911, and the curve showing the frequency of new cases in this hospital presents five notably high points, each the culmination of a wave of increase, in the period of two years and two months which it represents. In the first of these two waves the twenty-one new cases of July are followed by seventy-one in August, and this maximum by thirty-seven, twenty-three, twelve and three for the months of September, October, November and December, respectively. In January, 1910, there was but one new case; in February and March there were none; in April there was one; and with this a new wave started, reaching thirty-four new cases in June, dropping to but four in July, and rising in a second, lower wave of sixteen and fifteen in August and September, respectively, dropping thence to one in October and none at all until February of the following year.

The largest number of new cases occurring in 1911 was only seven, in August, the next largest number coming in May, when there were six, and the two crests of these waves being separated by the low period of June and July, with one and three cases, respectively. In a word, the two annual high points come in either May or June of two of these years,

and in August of three of them; while in the two years for which our records are virtually complete, the first wave is the highest in 1910, and the second is highest in 1911.

I believed at one time that we might make out a relation of succession between these separate waves of increase and the adult periods of successive generations of *Simulium*, but as my data accumulate this relationship becomes decidedly doubtful; and certainly these double pellagra periods can not be connected with any seasonal differences in the *abundance* of *Simulium*. If there were any causal relation between these two facts there should be but one high pellagra period to correspond with the single spring outrush of *Simulium* adults; or if there were another it should be much lower than the first.

Sambon reports a periodical character different from this observed in Illinois in the fact that it relates to an increased activity of pellagra—an intensification of its symptoms in individual pellagrins—occurring in spring and in fall, coincident, as he says, in Italy with the time of flight of two generations of the sand-flies; and he uses this fact to support his hypothesis of the dependence of the disease on the insects. Assuming that pellagra is produced by a protozoan parasite, he further assumes that the aggravation of symptoms twice each year is due to a migration to the surface of this hypothetical parasite, which is thus exposed to be taken up by the sand-flies as they draw blood from the skin of pellagrins. The summer and fall recrudescences of the disease he thus connects with the summer and fall abundance of the sand-fly imagos. His periods are, however, different from ours, the first coming in March or April instead of May and June, and the second in September or October, instead of August as in Illinois. I have not been able to learn from our physicians that any periodicity similar to this described by Sambon has been noticed in Illinois cases, but if it has it would be impossible to correlate it with the facts above described concerning the development of *Simulium* in our state.

There are other interesting points of contrast between our Illinois conditions and conclusions and those obtained by a study of the problem in Italy and in other parts of Europe. We are told, for example, that in Italy pellagra is a rural disease, to which town-dwellers are virtually immune, even where there is free communication between the town and adjacent pellagrous districts; but in Illinois we have every year several deaths from pellagra in our largest city, with a population of more than two million souls. Four cases of this disease have lately been reported to me from the private practise of Dr. Oliver S. Ormsby, secretary of the State Pellagra Commission, the sufferers from which had lived continuously in Chicago for years. Pellagra, in fact, can scarcely be said to be with us, as yet, a rural disease, the asylums in which ninety-six per cent. of the known new cases have occurred being in or very near cities and towns, and all cases reported from outside such institutions having come from the town and not from the country. The Peoria asylum, containing sixty-three per cent. of our known pellagrins, is in a suburb of our second largest city. It draws its patients from all parts of the state, but more than a third of them come from Chicago or its immediate neighborhood. Three other asylums, containing thirty per cent. more of our pellagrins, receive between sixty-three and one hundred per cent. of their inmates from Chicago. The closest relations of these especially pellagrous asylums thus seem to be with our largest cities and not with our rural districts. These facts would be more certainly significant, however, if pellagra had been longer known and more thoroughly studied throughout our territory, and if we had complete and reliable statistics from the state at large.

Simulium is said in Italy not to live in towns or to enter houses; but in the town of Havana, a village of thirty-six hundred inhabitants situated on the Illinois River near the central part of my state, it is so great a pest in spring that the people screen their windows to protect themselves from the bites of the black-flies; and we have seen these insects collecting there in great numbers on

the inside surfaces of the window-panes of public rooms, such as the offices of hotels. Furthermore, we have found biting species of *Simulium* breeding and emerging in large numbers, not only in the suburbs and outskirts of Chicago, but far within the limits of that great city—in the Chicago River, which traverses the city, passing through its most densely populated districts, and also in drainage ditches beside the streets when these happen to contain streams of running water for a sufficient time in spring. Indeed, it is not too much to say that *Simulium* may breed in any flowing stream within the city where the water is not offensively foul with sewage and other contaminations.

Reasoning from the time of the onset of pellagra in the case of certain infants born in November and in December, when sand-flies are not abroad in Italy, Dr. Sambon comes to the conclusion that the incubation period in these cases could not have exceeded three weeks, this being the interval to elapse between the time when these infants were first carried out in spring to the fields where they might have been bitten, and the date of the appearance of the rash which was the first symptom of the disease. If this reasoning is sound, and these infantile cases are fair examples of the incubation period of pellagra, then I am troubled to explain the occurrence in Illinois of two asylum cases—both reported as first attacks of the disease—one first manifest on the 24th of December, and the other on the 31st of that month, after a period of three or four weeks of severe cold weather. Our latest Illinois collections of *Simulium* adults made in any year were obtained November 5, and these cases consequently seem to have developed some six or seven weeks after any possibility of infection by means of *Simulium* bites. It is possible, however, that this discrepancy is only apparent, and that these were not new cases, arising in the asylum, but recurrent attacks of a disease originating outside and not previously recognized.

Simulium does not require, with us, swift-running streams for its development, some of the species, at least, breeding in any freely flowing water where the surface is broken into a ripple by depending or projecting objects. A stout weed growing from the bottom of a stream near its margin, or a twig bending down and dipping into the water from the shore, or even a trailing grass blade, will in many cases be thickly covered—but only on the up-stream side—with the larvæ first, and afterward with the pupæ, of *Simulium*. We have even found larvæ and pupæ, both in great abundance, coating objects on the bottom of the river at a distance from the shore and at a depth of nine or ten feet—a point in which our observations differ, so far as I know, from any others on record.

In Italy pellagra is said by Sambon to be essentially a disease of mountain valleys, but if this rule applied in America, we should have only imported cases of pellagra in any part of Illinois or, indeed, within hundreds of miles of its borders. There is, in fact, no common topographic feature distinguishing the three principal seats of pellagra in our state. The Peoria asylum, with two hundred and fifty-eight new cases in twenty-six months, is on a bluff about a hundred and fifty feet in height beside one of our largest rivers; the Elgin asylum, with thirty-eight new cases in the same time, is on a more sloping bank, less than half as high, beside a much smaller stream; and the Dunning almshouse is on a level open plain, with no water in its vicinity except a small drainage ditch, which often goes dry in midsummer. The country surrounding all these hospitals is a level or slightly rolling plain, originally covered with prairie grass except where streams were bordered with narrow belts of forest.

From the foregoing it will be seen that, although in this discussion I have been obliged to take a critical attitude towards the *Simulium* theory of this disease, our Illinois data are not, by themselves, conclusive either for or against that hypothesis. This is a source of regret to me, although scarcely a disappointment, as one entomologist, working for so short a time and in so limited an area, could scarcely expect to bring this time-worn

and complicated problem to the point of actual solution; and I must be content with bringing forward my personal contribution of matters of fact to this important inquiry, of a kind to require that they be taken into account in forming an adequate theory of this disease. In the meantime, whether the *Simulium* theory be finally justified or not, it should be especially welcome to us, as I intimated in the beginning, as giving us motive and opportunity greatly to increase our knowledge of these interesting insects; and it is particularly for this reason that I have ventured to bring this imperfect discussion of a problem yet unsolved before this congress of the entomologists of the world.

STEPHEN A. FORBES
UNIVERSITY OF ILLINOIS

EOANTHROPUS DAWSONI

A MEMORABLE and crowded meeting of the Geological Society was held in Burlington House, London, on December 18, to hear a paper read "On the Discovery of a Paleolithic Human Skull and Mandible in a Flint-bearing Gravel overlying the Wealden (Hastings Beds) at Piltdown, Fletching (Sussex)," by Charles Dawson, F.S.A., F.G.S., and Arthur Smith Woodward, LL.D., F.R.S., Sec.G.S.

Four years ago Mr. Dawson noticed that a certain road had been recently mended by peculiar flints, which he traced to a shallow pit. A little later he found that the laborers had dug out a "thing like a coco-nut," the fragments of which they threw on a rubbish heap. Mr. Dawson found there a part of a human skull which he showed to Dr. Smith Woodward; they realized the importance of the discovery, but kept it secret until they had time to exhaust the pit. This took a long time, as it is under water for six months in the year. Half of a mandible was found in the undisturbed gravel close to the spot where the skull occurred.

The gravel at Piltdown rests on a plateau 80 feet above the river Ouse and at a distance of less than a mile to the north of the existing stream. Thus denudation to the extent of 80 feet has taken place since the gravel was formed. In the gravel were found two broken pieces of the molar of a Pliocene type of elephant, a much rolled cusp of a molar of *Mastodon*, besides teeth of *Hippopotamus*, *Castor* and *Equus*, and a fragment of an antler of *Cervus elaphas*; all of which, like the human skull, were well mineralized with oxide of iron. Many water-worn iron-stained flints were obtained which closely resemble the artifacts from the North Downs near Ightham, to which the term "eoliths" is generally applied. A few implements of the characteristic Chellean type also occurred. The gravel is (archeologically) early paleolithic and (geologically) early pleistocene of about the same age as the Norfolk Forest Bed. Professor Sollas places the Chellean industry in the second genial episode of the Ice Age, but the artifacts of Ightham type, and the remains of elephant and mastodon were doubtless derived from an Upper Pliocene deposit.

Although the cranium is very fragmentary, the pieces recovered so abut on one another that an accurate contour of the brain case can be obtained, and a cast could be made of the cavity, which reveals the broad features of the brain. The cranium is typically human, and has a capacity of at least 1,070 c.c. It measures about 190 mm. in length from the glabella to the inion, and 150 mm. in width at the widest part of the parietal region. The bones are remarkably thick, the average thickness being 10 mm. The forehead is prominent and not receding as in the Neanderthal cranium, and the brow ridge is feeble; the occipital bone shows that the tentorium over the cerebellum is on the level of the external occipital protuberance, as in modern man. The temporal muscles extended higher up on the skull than in any recent or fossil man. When viewed from behind it is seen that the cranium is surprisingly broad and low. The mastoid processes are small. There do not appear to be any characters in the cranium which can not be matched severally in various existing human skulls. No facial bones were discovered. The right half of the mandibular ramus is nearly complete to the symphysis and lacks only the articular condyle and the

upper part of the bone in front of the molars. The horizontal ramus is slender, and resembles in shape that of a young chimpanzee (*Anthropopithecus niger*). The lower symphysial border is produced into a broad flat junction with that of the opposite side, being in this respect completely simian. The ascending ramus is broad, with extensive insertions for the temporal and masseter muscles, and has a very shallow sigmoid notch. Molars 1 and 2 are typically human, though they are somewhat large and narrow; each bears a fifth cusp; their cusps have been worn perfectly flat by mastication. The mandible is certainly the most remarkable feature of the find; although it bears some general resemblance to the Heidelberg jaw, it differs in being less massive, with smaller molars, a still more negative chin, and the simian symphysis. In making a model of the restored jaw Dr. Smith Woodward found he had too much room for the missing teeth and consequently was forced to leave a disastema between the canines and premolars, but on other grounds he believes that the canines were not specially prominent. The jaw as restored is wonderfully like that of a chimpanzee. Thus we have a being with what is virtually a human cranium and a simian jaw. The weakness of the mandible, the slight prominences of the brow-ridges, the small backward extent of the origin of the temporal muscles, and the reduction of the mastoid processes suggest that the specimen belongs to a female individual, and it may be regarded as representing a hitherto unknown species of man for which not only a new species but a new genus must be erected—Dr. Woodward bestowed on it the name of *Eoanthropus Dawsoni.*

Mr. Dawson gave an account of the finding of the specimens, the nature and geographical and geological position of the gravel bed and Dr. Smith Woodward described the remains in a most excellent manner. He pointed out that the skull of *Eoanthropus* was very different from that of *Homo monsteriensis* (*H. neanderthalensis*), and that it bore some resemblance to the skull of a young chimpanzee. He suggested that as the characters of the adult male chimpanzee's skull diverged considerably from the juvenile characters, so possibly *H. monsteriensis* may have diverged from a type like *Eoanthropus.* Professor G. Elliot Smith was called on to give an account of his investigation on the cast of the cranial cavity, and he pointed out that, while the general shape and size of the brain was human, the arrangement of the meningeal arteries was typically simian, as was a deep notch in the occipital region; he regarded it as the most ape-like human brain of which we have any knowledge. Sir Ray Lankester, Professor A. Keith, Professor Boyd Dawkins, Mr. Clement Reid, Dr. Duckworth, Professor Waterston, Mr. Reginald A. Smith and others discussed the paper.

There can be no doubt that this is a discovery of the greatest importance and will give rise to much discussion. It is the nearest approach we have yet reached to a "missing link," for whatever may be the final verdict as to the systemic position of *Pithecanthropus erectus,* probably few will deny that *Eoanthropus Dawsoni* is almost if not quite as much human as simian. The recent discoveries of human remains in the Dordogne region and elsewhere are demonstrating that several races of man lived in paleolithic times, and we may confidently look forward to new finds which will throw fresh light upon the evolution of man.

A. C. Haddon

THE YALE PERUVIAN EXPEDITION OF 1912[1]

On Thursday, December 19, the Yale members of the Peruvian Expedition of 1912 returned to New Haven. This, the third Yale expedition to Peru, was conducted jointly by the University and the National Geographic Society, the Yale members being Professor Hiram Bingham, '98, director; Professor Herbert E. Gregory, '96, geologist; Dr. George F. Eaton, '94, osteologist, and Mr. Osgood Hardy, 1913, assistant—Mr. A. H. Bustead, the chief

[1] From interviews with members printed in the *Yale Alumni Weekly.*

topographer, and Dr. L. T. Nelson, the surgeon, had returned a couple of days previously, having caught an earlier steamer from Panama. Messrs. K. C. Heald and Robert Stephenson, assistant topographers, will return in the course of a week or so. Mr. Joseph Little, assistant, decided to stay in Peru, having secured a position with the Dupont Powder Company. Mr. Paul Bestor, assistant to the director, had been invalided home two months previously, having suffered from a variety of tropical ailments. Mr. Ellwood C. Erdis, archeological engineer, is coming to New Haven *via* the Berlin Museum, where he proposes to spend some time studying the Peruvian collections there before undertaking the work of putting together the various broken pots that were excavated in the department of Cuzco.

Considerable illness, says Professor Bingham in interviews given since his return, overtook this year's expedition and various members were at times incapacitated. The only serious accident happened to Mr. Heald, who escaped death from falling down the face of a precipice only to rupture the ligaments of his collar bone. Nevertheless he carried out important reconnoissance work for a month after the accident but had finally to be ordered back to Cuzco by the surgeon, so that he was unable to penetrate the jungles of the Pampaconas valley as had been hoped.

The map makers, members of the party say, complain that the seasons are changing in Peru. They expected that the "dry season" would give them plenty of time and opportunity for work, but they found, as did the expedition of 1911, that in the great Peruvian Montaña, the jungles on the east slopes of the Andes, the "dry season" is only a relative term, and is much wetter than the "wet season" in some other parts of the world. They were also hindered by finding that valleys which last year had been noted for their salubrity were now the scene of two violent epidemics, smallpox and typhus fever alternating for the mastery. The prevalence of these virulent diseases also interfered with the plans for the anthropological work. Dr. Nelson, who was in charge of the anthropometric measurements, neither dared to leave the engineering party as long as they were exposed to fatal diseases, nor cared to expose the party to the dangers of having Indians from infected houses come to camp to get measured. As practically all the houses in the region were infected, a very serious interference for a period of two or three months was the result. Notwithstanding this, however, the surgeon did succeed in measuring nearly 150 Indians, using blanks prepared by Dr. Ferris of the Yale Medical School. Two photographs were taken of each subject, and also a large number of Indians were photographed who would not submit to being measured.

Professor Gregory's work was confined almost entirely to the vicinity of Cuzco and the Huatanay valley. The complex geological problems here presented occupied nearly his entire time in Peru. Results will be given out in a series of articles to be published as soon as possible. Mrs. Gregory accompanied him, and after the illness of one of the assistants was able in large measure to take his place, especially in the development of important photographs.

Dr. Eaton was unusually fortunate in being able to collect and bring home more than fifty cases of osteological and ethnological material which he collected in the vicinity of Cuzco in the ruins of Choqquequirau and especially in the ruins of the great city of Machu Picchu. In addition to more than fifty skeletons of the Machu Picchu people who were probably Incas or their immediate predecessors, he found a considerable amount of anthropological material in the burial caves. He also collected a number of bones of prehistoric vertebrates, including mastodon, horse and deer. In addition to his osteological and ethnological work, he had general charge of meteorological observations both on the way down and back and at Machu Picchu.

Arrangements were made with Mr. Burt Collins, the director of the Inca Mining Company, and with Mr. Claude Barber, the manager of the Santa Lucia mine, to undertake the care of four meteorological stations for a

period of five years. These stations will be completely equipped with self-recording instruments, and as they are at widely different altitudes the results should prove to be of considerable value.

The chief work undertaken by the expedition was in connection with the study of the ruins of Machu Picchu discovered by Dr. Bingham in 1911. As has already been stated, Dr. Eaton was in charge of the bone hunting and was fortunate enough to find a large number of caves containing skeletons and ethnological material. The clearing of the jungle and the excavating of the ruins was placed in charge of Mr. Erdis, whose four months at Machu Picchu resulted in about sixty cases of potsherds and pots, and two cases of bronze implements. The making of a large scale map of the ruins was entrusted to Mr. Robert Stephenson, who spent three months at a task which it is hoped will result in the construction of a model of this extremely interesting city. The construction of the model will also be assisted by the more than seven hundred pictures which Professor Bingham has taken of the ruins at different times. In addition to the archeological study of Machu Picchu Professor Bingham also devoted himself to exploring four or five sites of ancient ruins hitherto undescribed, and in a systematic effort to discover the ancient place names and to identify localities in the region occupied by the Incas during the last thirty-five years of their reign.

SCIENTIFIC NOTES AND NEWS

The British New Year's honors include the conferring of knighthood on Dr. Francis Darwin, the distinguished botanist; Dr. R. W. Philip, known for his work for the prevention of tuberculosis, and Mr. Stewart Stockman, chief veterinary officer to the Board of Agriculture.

Professor Ehrlich, of Franfort, has received the Bavarian Maximilian order for scientific services.

Dr. Imbeaux, of Nancy, has been elected a corresponding member of the Paris Academy of Sciences in the Section of Agriculture.

A testimonial is planned to Sir Patrick Manson on the occasion of his retirement in recognition of his work in tropical medicine. The testimonial will be national and international. The national testimonial will consist of a portrait and, it is hoped, a scholarship for the advancement of tropical medicine. The international tribute is to be in the form of a gold medallion.

The officers of the Geological Society of America for 1913 are as follows:

President—Eugene A. Smith.

Vice-presidents—James F. Kemp, R. D. Salisbury, C. D. Walcott.

Secretary—Edmund Otis Hovey.

Treasurer—Wm. Bullock Clark.

Editor—J. Stanley Brown.

Librarian—H. P. Cushing.

Councilors—A. H. Purdue, Heinrich Ries, S. W. Beyer, Arthur Keith, Whitman Cross, Willet G. Miller.

Chairman of the Cordilleran Section—J. C. Branner.

Secretary—Geo. D. Louderback.

Councilor—W. S. Tangier Smith.

At the meeting of the Society of American Bacteriologists, held in New York on December 31 and January 1 and 2 the following officers were elected:

President—Professor C.-E. A. Winslow, New York City.

Vice-president—Professor Chas. E. Marshall, Massachusetts Agricultural College, Amherst, Mass.

Secretary-treasurer—Dr. A. Parker Hitchens, Glenolden, Pa.

Council—W. J. MacNeal, L. F. Rettger, D. H. Bergey, H. A. Harding.

Delegate to Council of American Association for the Advancement of Science—Professor S. E. Prescott.

At the recent meeting of the American Anthropological Association held in Cleveland, Ohio, the following officers were elected:

President—Professor Roland B. Dixon, Harvard University.

Secretary—Professor George Grant MacCurdy, Yale University.

Treasurer—Mr. B. T. B. Hyde, New York.

Editor—Mr. F. W. Hodge, Bureau of American Ethnology.

AT the Boston meeting of the American Economic Association Professor David I. Kinley, of the University of Illinois, was elected president for the meeting to be held next year at Minneapolis.

PROFESSOR WILLIAM A. DUNNING, of Columbia University, was elected president of the American Historical Association. The next meeting will be held in Charleston and Columbia, the following meeting at Chicago and a special meeting during the summer of 1915 at San Francisco.

THE Academy of Natural Sciences of Philadelphia has named Dr. Edward J. Nolan, Professor Ulric Dahlgren and H. S. H. The Prince of Monaco as delegates to the Ninth International Congress of Zoology.

LIEUTENANT WILHELM FILCHNER, the German Antarctic explorer, returned with his expedition to Buenos Ayres on January 7 after an absence of fifteen months in the southern seas. He cables from Buenos Ayres that the expedition has been most successful. Lieutenant Filchner purposes continuing his explorations.

DR. WILLIAM CURTIS FARABEE has resigned from Harvard and has accepted a position at the University of Pennsylvania. He will take charge of an expedition to South America, the primary object of which is ethnological study, although scientific men in other departments will accompany the expedition. A steam yacht has been provided and equipped for the comfort and safety of the members of the expedition and for the prosecution of the scientific inquiries for which it is organized. Investigations will be conducted along the Amazon and its tributaries and in the northern part of South America. Provision has been made to keep the expedition in the field for three years.

PROFESSOR ROLLIN D. SALISBURY, head of the department of geography and dean of the Ogden School of Science of the Chicago University, has returned from South America, where he had been investigating the glacial formations of Argentina and Patagonia.

MR. CLINTON DEWITT SMITH is about to return to this country from Brazil. He organized and became president, five years ago, of the first agricultural college in Brazil, intended as a model for other colleges. Professor Smith was for fifteen years director of the Experiment Station of the Michigan Agricultural College.

PROFESSOR M. M. METCALF, head of the department of zoology at Oberlin College, has been granted leave of absence for travel and study during the second semester.

AT the annual meeting of the Washington Academy of Sciences, on January 15, Dr. Frederick V. Coville gave the address of the retiring president on the formation of leaf mould.

THE sixth Harvey Society lecture will be given on January 18 at the New York Academy of Medicine by Major Russell, of the United States Army, on "The Prevention of Typhoid."

THE Minnesota local section of the American Chemical Society had recently a special lecture on "The Electron Theory," by Professor W. A. Noyes, director of the chemical laboratories of the University of Illinois.

DR. L. O. HOWARD, chief entomologist of the U. S. Bureau of Entomology, lectured before the undergraduates of Oberlin College on January 7, speaking on certain types of noxious and beneficial insect life. Professor Winterton C. Curtis, of the University of Missouri, lectured there on January 8 on "The Social Value of Abstract Research."

IT has been proposed to the municipal authorities of Paris that the memory of Henri Poincaré should be honored where he taught, and it is suggested that the portion of the Rue Vaugirard between the Boulevard St. Michel and the Odéon should be named after him.

A CELEBRATION of the centenary of the birth of James Dwight Dana (1813–1895) was held at Yale University on December 29, in connection with the annual meeting of the Geological Society of America. President Hadley presided and referred in his introductory remarks to Dana's pioneer work in zoology and

geology. Professor William North Rice, of Wesleyan University, read a paper on "Dana the Man"; Dr. E. Otis Hovey, secretary of the Geological Society and curator of geology at the American Museum of Natural History in New York City, spoke on "Dana the Teacher"; Dr. George P. Merrill, head curator of geology of the United States National Museum at Washington, spoke on "Dana the Geologist," and President Fairchild, of the Yale Alumni Association, read the paper on "Dana as a Zoologist," written for the centenary by John Mason Clarke, director of the Science Division of the Department of Education of New York State. Books, pamphlets, monographs, greetings from learned societies and personal memorabilia were exhibited in Chittenden Library during the week.

Mr. Thomas Howell, the well-known Oregon botanist, died on December 3, 1912. He was born in Missouri on October 9, 1842, and was a pioneer of Oregon, moving there in 1850. Although he had very scanty schooling, Mr. Howell was far from being an uneducated man. He devoted many years of his life to the study of the flora of Oregon, tramping over nearly every portion of the state. His knowledge of the northwestern flora is embodied in the work entitled "The Flora of Northwestern America." Perhaps the most noteworthy discovery of Mr. Howell was the finding of *Picea Breweriana*, a very local tree and the last of the Pacific Coast conifers to be discovered.

Dr. Peter Redfern, formerly regius professor of anatomy and physiology in Queen's College, Belfast, died on December 22, at the age of ninety-one years.

Dr. A. Pfarr, professor of hydraulics in the Technical School at Darmstadt, has died at the age of sixty-one years.

The papers on the program for the Cleveland convocation week meeting were distributed among the sciences as follows:

Mathematics	49
Astronomy	35
Physics	52
Engineering	40
Geology	27
Zoology	84
Entomology	73
Botany	60
Phytopathology	49
Horticulture	53
Anthropology	27
Psychology	56
Biological chemistry and pharmacology	63
Anatomy	63
Physiology	67
Education	11
Economics and Sociology	13
	822

The department of superindence of the National Educational Association will meet at Philadelphia from February 24 to March 1. With it meets the National Council of Education, the Department of Normal Schools, the National Society for the Study of Education and a number of other educational societies.

President Taft in a special message to congress, on January 8, recommended the repeal of the act of congress which prohibited for five years the killing of fur seals on the Pribilof Islands, passed a year ago. Investigation, the president said, showed a remarkable increase in the size of the herd in one season and proved conclusively that only the female seals and the bull male seals need protection, and that thousands of "bachelor" seals can be killed each year without reducing the herd. The act which should be repealed was adopted to give effect to the first seal treaty of 1911 between Great Britain, Japan, Russia and the United States. Although a clause in that treaty, the president points out, seems to give the United States authority to suspend land killing to protect and preserve the herd, if no actual necessity were found for such suspension it was not justified under the convention and the act should be amended.

The board of managers of the Marine Biological Association's laboratory at Plymouth, England, has recently decided upon a policy of emphasizing the purely scientific and international character of the institution, thus rendering it more readily accessible to American students than it has been in the past. In its equipment it is second only to Naples, being well supplied with apparatus and chemicals required for advanced research, and provided with a steamer of 69 tons burden. An effi-

cient staff of attendants is maintained and every effort is made to meet the special requirements of those who occupy tables, especially when the work is of a physiological or chemical character. Many important papers have emanated from the laboratory during the past three years, and the new policy inaugurated by the board of managers may be expected to render the laboratory the "Naples of the North," and advanced students who contemplate the prosecution of researches upon the marine fauna of northern Europe may advantageously write to the director of the Plymouth Laboratory, Citadel Hill, Plymouth, England, for specific information.

MR. NELS C. NELSON, assistant curator in anthropology at the American Museum of Natural History, has returned from an archeological expedition to the southwest. A systematic search for archeological sites was begun at Ysleta del Sur, a few miles below El Paso, and completed northward to the latitude of Santa Fé. Within this section of the drainage 115 sites of more or less interest were located and about half of these were inspected. Actual excavations were conducted in two localities. First a group of seven large Tanos pueblo ruins, located on the border of the Galisteo Basin twenty-five miles south of Santa Fé, were worked to the extent of determining their age and culture relations; and later one entire Keresan pueblo ruin, located on the Jemez National Forest seven miles northwest of Cochiti, was cleared. Besides digging trial trenches and examining refuse heaps, four kivas and 573 ground-floor rooms were cleared. The débris removed from these rooms ranged in depth from two to twelve feet and represented, with few exceptions, two and three story houses. The resulting collections comprise sixty more or less complete human skeletons and about two thousand artifacts.

DURING the week of January 6 a "Mental Hygiene Exhibit and Conference" was held at Yale University under the joint auspices of the National Committee for Mental Hygiene and the Connecticut Society for Mental Hygiene, assisted by representatives of Yale University. The public exhibition of the work of the National Committee for Mental Hygiene will later be given in Chicago, Princeton, Baltimore, Boston, and Philadelphia, and is designed to give tangible evidences of the need of public information as to the causes, treatment and prevention of mental disorders. It has already been shown in Washington and New York. Speakers announced to make addresses during the week were: Dr. Henry Smith Williams, of New York City; Dr. Stewart Paton, of Princeton; Dr. George Blumer, dean of the Yale Medical School; Dr. August Hoch, director of the Psychiatric Institute of the New York State Hospitals on Ward's Island, New York City; Dr. George H. Kirby, clinical director, Manhattan State Hospital, New York City; Dr. C. Macfie Campbell, of the Bloomingdale Hospital, New York; Professor William H. Burnham, of Clark University; Dr. Thomas W. Sallmon, New York, and Dr. S. E. Jeliffe, of Fordham College.

THE United States will be the meeting place of the Fourth International Congress on School Hygiene. The preceding congresses have all been held abroad, the first at Nuremberg in 1904, the second at London, 1907, and the third at Paris, 1910. The 1913 congress will be held at Buffalo, N. Y., August 25–30. It is the object of the congress to bring together men and women interested in the health of school children and to assemble a scientific exhibit representative of the most notable achievements in school hygiene. It is believed that the present wide-spread public interest in health education will make the exhibit a particularly attractive feature of the congress. Twenty-five nations have membership on the permanent international committee of the congress and it is expected that all will have delegates at Buffalo. The Secretary of State has officially invited foreign governments to participate. Invitations have also been issued to the various state and municipal authorities, and to educational, scientific, medical and hygienic institutions and organizations. The president of the congress will be Charles W. Eliot, president emeritus of Har-

vard University; the vice-presidents, Dr. William H. Welch, of Johns Hopkins, and Dr. Henry P. Walcott, of the Massachusetts Board of Health. The long list of honorary vice-presidents includes: Dr. Abraham Jacobi, of New York City; Dr. William H. Burnham, of Clark University; Cardinal Gibbons; Dr. P. P. Claxton, United States Commissioner of Education; Surgeon-General Blue, of the Public Health Service; Dr. H. M. Bracken, of the Minnesota State Board of Health; President David Starr Jordan, of Leland Stanford Junior University; Dr. Woods Hutchinson, representing the National Education Association, and many other distinguished physicians, educators and civic experts.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. John R. Strong has given to the New York State College of Forestry at Syracuse University for use as a forest experiment station 100 acres of forest land at Tannersville in the Catskills, including a summer residence. The tract will be used as a forest experiment station and for a students' camp in the summer.

Williams College has received $20,000 from the estate of John Savary, '55, of Washington, D. C. The income from this amount is to be used for the purchase of books for the library.

Western Reserve University has received from Mr. Henry F. Lyman, of Cleveland, a large collection of shells, corals and agates. The collection is one begun by Mr. Lyman during a visit to the Hawaiian Islands in 1875.

Science Hall of Ohio University, Athens, Ohio, has been completed and is now occupied by the three departments of physics, chemistry and biology. The building is a four story structure of red pressed brick, 79 feet by 124 feet, costing about $120,000. The department of physics and electrical engineering occupies the first two floors. These will provide recitation rooms and offices for the instructors in the department; a large laboratory for general physics, with two dark rooms and apparatus rooms attached; laboratories for the various advanced courses in physics, with the necessary weighing rooms and apparatus rooms; a laboratory for electrical measurements, with apparatus rooms and weighing rooms attached; a dynamo motor and transformer laboratory; a photometric laboratory; a storage battery room; high temperature laboratory; unpacking room; storage rooms; several small research laboratories; constant temperature laboratory; drafting room; shop; private laboratory; library and reading room. The other departments are correspondingly arranged.

A course in general science leading to the degree of bachelor of science is offered for 1913–14 in the College of Arts and Sciences of the University of Vermont. This course is similar to the A.B. and Ph.B. courses in its adherence to the group system, but differs from them in requiring mathematics and physics and a larger amount of work in the scientific group of studies. The course is intended for those who intend to teach the sciences in secondary schools and for those who desire a broad scientific training before entering a technical or professional school. The entrance requirements of the new course lay stress on the sciences rather than on the languages.

The Massachusetts Institute of Technology will hold a reunion of alumni in New York City on January 17 and 18. There will be special trains from Boston and probably from Washington and Philadelphia. The plans include class luncheons on Friday and a mass meeting in the afternoon; society and fraternity breakfasts on Saturday, departmental luncheons and a banquet in the evening. At the mass meeting on Friday afternoon the following have accepted the invitation to speak: President R. C. Maclaurin, Mr. John R. Freeman, Professor D. R. Dewey, Professor A. A. Noyes and Professor W. T. Sedgwick. Speakers at the department luncheons will include the following:

Course I.—Professor C. M. Spofford, Professor G. F. Swain.

Course II.—Professor E. F. Miller, Professor G. Lanza, Dean Goss, of the University of Illinois.

Courses III. and XII.—Professor R. H. Richards and Professor W. Lindgren.

Course IV.—Professor F. W. Chandler and Professor J. Knox Taylor.

Courses V. and X.—Professor H. P. Talbot and Professor W. H. Walker.

Course VI.—Professor D. C. Jackson, Professor Elihu Thomson, Mr. Gano Dunn.

Courses VII. and XI.—Professor W. T. Sedgwick and Mr. Rudolph Hering.

Courses VIII. and XIV.—Professor C. R. Cross and Professor H. M. Goodwin.

Course IX.—Professor D. R. Dewey and Professor H. G. Pearson.

Course XIII.—Professor C. H. Peabody.

At the banquet on Saturday night President Maclaurin, President A. C. Humphreys, of the Stevens Institute of Technology, and Mr. John V. Bouvier will be among the speakers.

DISCUSSION AND CORRESPONDENCE

A NATIONAL UNIVERSITY AT WASHINGTON

THROUGH the courtesy of President Charles R. Van Hise, of the University of Wisconsin, the writer is just in receipt of a reprint from SCIENCE, of August 16, 1912, entitled "A National University, a National Asset; an Instrumentality for Advanced Research," the same being an address delivered by him at the 1912 meeting of the National Education Association.

The paper is a clear, comprehensive and practical exposition of the desirability and possibility of the fullest practicable systematic utilization, by those having the bachelor's degree with a year's subsequent practical work, of the extraordinary research facilities at Washington, embracing physical science and sociology (the latter including anthropology, political economy, political science and history), with such lectures by government officials as will direct the work to the highest efficiency. As such, the paper is a valuable contribution to the subjects involved, and is so excellent, as far as it goes, that the writer is reluctant to say aught in criticism, and does so only because the cause of education seems to require it.

The paper is not more noteworthy for what it advocates than for what it might be expected to advocate. Its negations are quite as marked as its affirmations. The first paragraph is as follows:

> At the outset, the guiding principle may be laid down that at Washington there is no necessity for a university of a type which exists elsewhere, no need of an additional university like the great endowed and state universities of the country. One who advocates a national university at Washington with the idea that it shall be a larger Harvard, Yale, Columbia, Cornell or Chicago, a larger Michigan, Illinois, Wisconsin, Minnesota or California, will fail in his advocacy, because he can not give to Congress a sufficient reason for the expenditure of public funds for another university of a kind of which there is a sufficient number. Not only would such an advocate be met by the above fact, but by the fact that in Germany, where universities are most highly developed, they are state, not national institutions.

In the first place, the statement with respect to Congress is opinion only. In the writer's judgment, sufficient reasons *have* repeatedly been given to Congress, and if Congress has not been appreciative enough of the higher education, the fault has been not with the reasons, but with Congress. The mere fact that Congress has heretofore disregarded the proposals of the most distinguished committee ever constituted in an educational interest (although having a Senate standing committee on the University of the United States which in recent years has made four favorable reports, all but the third unanimous) is no reason for not continuing the campaign until Congress either recognizes the merits of the case or capitulates in the spirit of the unjust judge of Biblical parable.

As for Germany, it needs but be said that, if she has not yet attained the national university conception, she is on the way to it, and the German mind can be trusted to work out the problem of university education to its logical result.

And so the question reverts to the "guiding principle" of the paper. If the writer be not mistaken, there were Wisconsin colleges, excellent for their day, already existing when the

University of Wisconsin was inaugurated. What need, or "necessity," to use the word in the paper, was there for the institution over which President Van Hise is proud to preside? If Michigan, Indiana, Illinois, Iowa and Minnesota had state universities, and Wisconsin had none, would he not, as a resident of Wisconsin and an educator, not only advocate a state university for Wisconsin, but also wish it made as broad and strong as possible—if practicable, "larger" than the others? Indeed, would he deprecate the establishment of a first-class state university wherever there is none to-day? It is not likely. Then why discriminate against the District of Columbia, the nation's ground, and deny it the high privilege of an institution of the "university type," commensurate with the ideals, needs and resources of the nation?

He has faith in the "university type" of education in the states. He considers it there a very valuable and noble agency. But when he enters the District of Columbia his faith leaves him. What is the matter? Is not the nation but a larger state? Is the genius of the nation unsuited to the conduct of the fullest instrumentalities of education? Is the national atmosphere unsuited to that form of institution, the "university type," which both the reason and the experience of mankind in all ages have proven the most fit for the development of the higher learning, and which has served its purpose elsewhere so admirably? Apparently so. For, when he leaves Madison as an educator, he arrives at Washington chiefly as a scientist. What has transformed—contracted him? Has the spirit of the broadest learning, fostered in his northern home, become enervated by his removal to a more southern clime? Has the materialistic and commercial spirit of the age, which he withstood so nobly in Wisconsin, gained the ascendancy on the banks of the Potomac? Has he lost that priceless gift of the mind—vision? Whatever be the reason, his educational view has narrowed, and in the capital of his country, where, if anywhere, it might be expected to be comprehensive, it is principally limited to the sciences. Swedenborg, to be sure, saw that science, with all its uses, is but the husk of knowledge. But Swedenborg would be laughed out of a modern court of science. Science (unfortunately) has little use for seers. And so, for some unexplained reason, it is illegitimate, or unwise, or unsafe, or inappropriate, or impracticable, to do at Washington, in the name and with the support of the nation, what it is eminently legitimate, and wise, and safe, and appropriate, and practicable to do, to a less extent, at Madison, for instance, in the name and with the support of the state of Wisconsin.

Is President Van Hise any more a citizen of Wisconsin than a citizen of the United States? Does his ambition for American education halt at state lines? Would he have pride in no institution of the "university type" beyond the state and privately endowed universities? Are not these institutions, however great and strong, constantly seeking enlargement, and likely to continue to do so indefinitely? And yet do not they themselves recognize the significant fact that, with every increase of knowledge, the domain of the unknown, so far from decreasing, only expands to the view? If the first love of these institutions be for learning, why should not they welcome any new institution of the "university type," whether less or "larger" than themselves, calculated to assist in the search for truth—and welcome it the more in proportion to its power and importance? Is it possible that they imagine themselves, with their ever necessary limitations, the only institutions of the "university type" needed for the exploration of the boundless fields of knowledge? Can he be satisfied with them, or they with themselves, when a greater institution of the "university type" than any of them can ever hope to become may be created by the nation as a co-worker and helpmeet in the domain of universal learning? Can institutions of the "university type" be too numerous, or any one of them too "large" to realize the sublime conception of Johann Keppler, "the legislator of the heavens," when he exclaimed: "O God, I think thy thoughts after Thee!"? Will President Van Hise

mention a single argument, valid for a state university, that will not be at least equally valid for a national institution of the "university type"?

The state and privately endowed universities have done a noble educational work, and are contributing much to the advancement of American civilization. And it is no fault of theirs that they can not perform a nation's educational service. It is no disparagement of them that a national institution of the "university type" can do what they, either individually or collectively, will never be able to accomplish. It is the function of nationality to effect more than what is possible to lesser entities, and in no field of service can the national power confer a more signal benefit upon humanity than in the cultivation of the highest and broadest learning. In so far as a nation fails in this regard, it is especially recreant to its trust. And the educator can do his country no finer service than in persuading the nation to be true to itself by providing, in its own great name, the fullest instrumentalities for the pursuit of knowledge universal. Nor can these agencies be furnished in any form so well as by the establishment at the national capital of an institution of the time-tested "university type"—an institution analogous to the eloquent Charles Sumner's "grand temple of universal peace, whose dome shall be as lofty as the firmament of heaven, as broad and comprehensive as the earth itself"—such a university as was in the prophetic vision of the writer's recently deceased father, Ex-Governor John W. Hoyt, for the last nineteen years of his life chairman of the National Committee of Four Hundred to promote the establishment of the University of the United States, when he wrote:

a broad and noble institution, where the love of all knowledge, and of knowledge as knowledge, shall be fostered and developed; where all the departments of learning shall be equally honored, and the relations of each to every other shall be understood and taught; where the students devoted to each and all branches of learning, whether science, language, literature or philosophy, or to any combinations of these constituting the numerous professional courses of instruction, shall intermingle and enjoy friendly relations as peers of the same realm; where the professors, chosen as in France and Germany, after trial, from among the ablest and best scholars of the world, possessed of absolute freedom of conscience and of speech, and honored and rewarded more nearly in proportion to merit, shall be, not teachers of the known merely, but also earnest searchers after the unknown, and capable, by their own genius, enthusiasm and moral power, of infusing their own lofty ambition into the minds of all who may wait upon their instruction; a university not barely complying with the demands of the age, but one that shall create, develop and satisfy new and unheard of demands and aspirations; that shall have power to fashion the nation and mold the age unto its own grander ideal, and which, through every change and every real advance of the world, shall still be at the front, driving back from their fastnesses the powers of darkness, opening up new continents of truth to the grand army of progress, and so leading the nation forward and helping to elevate the whole human race.

But President Van Hise apparently does not wish any such institution as that. He would have the state or privately endowed universities—necessarily the less competent agencies—attempt the broader educational labors, and leave the narrower work to the nation—inherently the more capable instrumentality. The greater field is too high and "large" for the nation. Some of the organic constituents of the nation, with other scattered agencies, can perform the national educational function better than can the nation itself. With all respect to the distinguished gentleman, the writer is impelled to ask, Could provincialism go further? His university attitude at Washington is what might be anticipated of a scientist, but is it what would be expected of an educator?

And so, why should *not* the nation establish, maintain and develop, in its name and at its capital, an institution of the "university type," calculated to become eventually the leading university of the world? The essential reason for such an institution, as has been shown, is, not that it may be "larger" than some other, but that, it being supported by the nation, the cause of learning and of truth will

be more fully served than will otherwise be possible. And this reason is not only legitimate. It is controlling. The claims of these high interests are paramount, and no lesser institutions or interests can properly be allowed intervention at the bar of American education.

A word on a subsidiary matter—degrees. The paper would deny to the national institution it advocates the power to confer them. Now, the writer assumes that President Van Hise desires for his proposed institution every agency that will contribute to its attractive force and its standing in the learned world. But will he say that degrees will not contribute powerfully to these important ends? Have not degrees in all ages been proven stimulants to study, certificates of attainments, and passports to practical opportunities in after life? Would not an institution lacking authorization to confer them be necessarily handicapped and lowered in the estimation of other institutions and hence its usefulness and honor be diminished? He of course appreciates the value of degrees both to students and to institutions, but he would confine them to the state and privately endowed universities. He says:

> After a student has continued his work at Washington to the point where he would have a doctorate, he may take his examination and qualify himself for his doctorate at the institution at which he previously studied, and thus add to the prestige of that institution. Naturally, a part of such qualification would be a thesis prepared by using the material in the bureaus and departments.

A remarkable proposal—quite as surprising an anomaly as the paper's "guiding principle"! What would President Van Hise say if a student, after completing an undergraduate course at the University of Michigan, for instance, should take a graduate course at the University of Wisconsin, and then return to the University of Michigan for his examination, thesis and doctorate? Is it too much to say that the president of the University of Wisconsin would make a vigorous protest? And rightly. The laborer is worthy of his hire. Honor to whom honor is due. Fortunately, the spirit of equity among American universities would not permit such an infringement of university rights. But what he would resent for his state he proposes for the nation. He would give his state her dues, but in the case of the nation he would add insult to injury and put it off with a defrauded as well as a fragmentary institution. How will the spirit of equity among our institutions of learning meet such a real proposal as this?

Would a degree lose its value because conferred by a national institution? Indeed, would not its value be thereby indefinitely enhanced? And at the same time, would not the very fact that other institutions of the country were made the necessary gateways to the national institution operate to augment and strengthen those other institutions? If degrees are desirable for the University of Wisconsin or for Harvard, by what process of reasoning are they found undesirable for the national institution proposed in the paper? Is there more concern for the prestige of the state and privately endowed universities than for the prestige of the national institution?

Had the paper not laid stress on the "prestige" of the state and privately endowed universities of the country, the writer would say no more on that subject, for the word, as used, involves more than one unacquainted with the history of the national university movement would imagine. "Prestige," and its offspring, pride! There is pride, and there is pride, and they differ as darkness from light. There is pride which concerns individuals, as such, and which is loath to see any "larger" excellence than that rendered possible by its own circumstances. And there is pride with an eye single to the content of that which another is better circumstanced to accomplish, and individuals, as such, are forgotten in the greater good. Which form of pride shall characterize American education?

The paper is candid enough to admit that such an institution as it advocates would not properly be called a "university" at all. It says:

> If there be prejudice against calling the institution above described a national university, it

may be given some other name, since as a matter of fact the institution proposed would be different from any existing university in that it would not profess to give a complete system of courses regarding any subject, but would give such specialized courses as the facilities at Washington made advantageous; and also it differs from a university in the respect that it would not grant degrees.

The university title for such an institution would indeed be a misnomer and hence misleading and indefensible. The present writer, as is evident, has in view for his country a true national university. By the term "university," undergraduate as well as graduate work is generally understood, inasmuch as most of the work done in institutions bearing that title always has been, is, and ever will be undergraduate. As a matter of fact, however, the national university advocacy, almost from Washington's day to this, has been for an institution that would not be a rival to any others—for an exclusively graduate university—an institution that shall stimulate, elevate, standardize, coordinate and supplement American public education, utilize the government facilities, conduct government researches and investigate the unknown; inspire ambition for the highest learning, maintain cooperative relations with other institutions and increase their patronage by making its honors the goal of their graduates; foster nationalism, provide the educational facilities which Americans seek abroad, and, by attracting foreign students, diffuse democratic ideas—an institution that will, to an extent possible to none other, whether one or all, advance the cause of learning and give the United States a new and supreme dignity and influence.

The people of the District of Columbia are, indeed, entitled to an undergraduate as well as graduate institution of learning, and one of the former grade could be affiliated with the latter. But the District is a very small fraction of the United States. The supreme need is for learning and for the nation, for the highest and broadest institution possible of the "university type" at Washington—a need to be measured both by what the institution can do for learning and for the nation, and by what the nation can do for the institution—a need which, so far from decreasing with the growth of other institutions, increases with the years, as the nation becomes greater and as the infinity of truth is ever more fully realized.

There are offences of omission as well as of commission. It is bad enough to offend at all against one's country. But the paper under consideration, in presuming to set bounds to educational opportunities under the national name and auspices, and in the fullest and most fruitful form yet evolved—an institution of the "university type"—commits a yet graver offence—an offence against learning. No man and no set of men can afford even half-disloyalty to that sacred cause. The instrumentalities for the pursuit of knowledge may be circumscribed only to the ultimate disappointment of those audacious enough to attempt the curtailment of its beneficence. The temple of universal learning has no forbidden shrines or prohibited forms of worship, whether for an individual, a state, or a nation, and they who would pronounce any interdict there must reckon with the everlasting law of progress.

(Since the above was written, the writer has received a letter from President Van Hise, in answer to one remonstrating against the apparent lacks in the SCIENCE paper. President Van Hise says:

> In response to your letter regarding a national university, I have to say that I advocated the ideas presented in my paper with the belief that the steps there suggested should be the first ones. As a matter of practical expediency, it seems to me to be wise at the present time only to push for those ideas regarding a national university of which there is some chance of acceptance. If the steps I advocate were made at first, it is my conviction that the future would take care of itself. With a national university once founded, its growth would take place wherever sooner or later it appeared such growth would be advantageous to the nation.

If President Van Hise intends the institution he advocates as the beginning of a real national university, the author is gratified, but the paper gives no hint of such intention, with

respect either to its scope or its degree-conferring power—its constitution, in a word, as an institution of the "university type"—and, while it may be necessary to begin as he suggests, the writer deems it important to keep the ideal before the country, and so lets the paper stand as written.)

KEPLER HOYT

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NEO-VITALISM AND THE LOGIC OF SCIENCE

TO THE EDITOR OF SCIENCE: In the discussion to which you have recently given space concerning the availability for science of the system of implications to which vitalism and the conception of entelechies lead, it is important to refresh one's memory concerning the general methodological postulates of science, for in the final analysis every special argument in such a case is nothing but the assertion of a specific point of view in regard to the system of conceptions with which science works in reducing the world of phenomena to order.

The conception of intelligible order is the product of a slow intellectual development which is reenacted by every human society in its progress toward civilization and by every child in its growth toward mental adulthood. Between the theoretical limits of a world of anomy and the assumption of necessary law the evolution of this concept presents an infinite series of modifications. The universal presence of law is the underlying assumption on which all investigation proceeds, and the advancement of science is measured by the field which it has redeemed from chaos and conceived in terms of intelligible order. But in certain of its relations this conception is scarcely more than a theoretical postulate which expresses a logical conviction as to the nature of the world and inspires the persistent search after new laws. It expresses the belief, in regard to each unreduced phenomenon, that the logical canons which have guided investigation to a triumphant conclusion in other fields must ultimately be found valid here also.

As to the phenomenal basis of such conceptions common observation sufficiently establishes the fact of recurrence, both of elements and complexes. Familiarity with these connections of experiences, however, does not carry the mind inevitably toward their uniformity. Man's first uncritical reflection leads only to the general expectation of recurrence. Failures and fulfilment must equally be accepted as facts. In one field order prevails, in another, caprice. It is an empirical inference which no more assumes necessary connection as its reflective postulate in the one case than it does anomy in the other. But the human mind is not content to rest at this stage. The world of phenomena is not a pure object of contemplation. It is endowed with energy and penetrated with living potencies and purposes, conceived in terms of agents and active causes. These spiritual powers in whom change is grounded are unique as well as individual, and each is marked by a characteristic activity. The world must be taken as it is found; if unpredictable as well as dependable successions occur, the causes to which they are referred must correspondingly vary. Arbitrary and capricious wills appear on the theater of events along with those which are consistent and inalterable. Wonder and miracle lie embedded in the world's structure alongside of established and predictable order.

The habit of thus conceiving phenomena in terms of disparate principles dies hard. It yields only before the slow extension of law as the investigations of science are pushed farther and farther and one range of phenomena after another is brought under control. At first it is not perceived by the scientist himself that the postulate of universal and necessary law underlies all his procedure, that the conception of uniformity is not confirmed by the slow accumulation of evidence but constitutes the basis of every conclusion he draws. The principle of all scientific method is established only when this relation is first clearly apprehended. As the connections of phenomena are more widely discerned the region of anomy undergoes progressive limitation and the world of miracle gives

place to a universe of law. Order replaces disorder, necessity supplants chance in the thoughts of men, until the realm of experience is finally viewed as a consistent and rational whole, wherein every change is conditioned by uniform antecedents and expressible in terms of natural law.

The application of this point of view, it may logically be said, implies a preliminary treatment in which phenomena are organized in a unitary system of classifications on the basis of specific resemblances and differences. But the process of defining and naming, of conceiving individuals in terms of fixed characteristics and referring each to its place in a logical scheme may be said merely to provide the data for the mind's final operation whose field is the interaction of things. The world is treated dynamically as well as statically. The subject of specific characteristics is also the origin of certain effects. It has its place in a causal series as well as in a classificatory system. The logical relations of likeness and difference must be supplemented by the empirical relations of genesis and historical origin. To connect events in this way is to explain them. The world as a system of objects can only be described; to be explained it must be conceived as a system of orderly successions in time. The universal principle of explanatory science is thus to be found in what is termed the conception of causal relation, since it is simply the generalization of this idea of uniformity in historical succession. Natural science therefore rests finally upon the assumption of mechanism and excludes all other conceptions.

Historically the explanations of science have been supplemented at every stage by principles dependent upon the assumption of purpose or function, but every such recourse represents a failure in the scientific undertaking or a loss of the scientist's vision. Its interpolation indicates either the presence of an unresolved problem or a confusion as to the nature of scientific explanation. The ideal of science is, from the methodological point of view, perfectly clear; it is to determine the atomic constitution of the world and to formulate the mechanics of its changes. The particular constitution of the units and formulas with which the scientist works may vary from age to age, since these are necessarily provisional and relative to the level of analysis attained at any given time; but the formal ideal of all analysis is unaffected by such changes and remains theoretically constant. The unit must be simple, the formula universal. No ultimate difference among the constitutive units, and no partition of the world between irreducible forms of change can be admitted. This is the fundamental assumption from which the scientist can not allow himself to be swerved by any complication of the phenomena to be treated or any difficulty in their resolution.

Such a postulate can be maintained only in view of the fact that science is not an attempt to exhaust the account of reality, and that its presuppositions constitute but a necessary methodological delimitation. Reality is viewed by man in a series of differing relations, each of which involves a specific set of such presuppositions. With none of these other points of view, however, can science have even contact; and the penetration of his own field by the conceptions to which they give rise can mean only the disorganization of his results.

The traditional form in which this adulteration of scientific method has been manifested is an employment of the conception of creative spirits, essences and powers as explanatory formulæ. Angels and demons, entelechies and souls, function and purpose, force and will; vitalistic, morbific and soporific agencies have been invoked in turn as explanatory hypotheses. It may be that human reflection has need of this whole class of conceptions in its complete review of reality; but in the special work which science in general undertakes they can afford no help whatever. Each relapse into such modes of thought marks the point at which scientific analysis has stopped and amounts to nothing more than the confused recognition of an irreducible element in experience. This the scientist must recognize as well as any other, but it is absurd to make

of it a constitutive or explanatory principle. It affords no means of analysis; it determines no specific change; it contributes no formula of relation. At whatever level it appears this conception stands only for the unresolved residuum by which reflection is faced.

Thus in the study of organic life it may be that the biologist is unable to state the facts of development in terms of the known chemistry of the cells, or of the local relation of parts in the segmented ovum and their polarities and bilateralities, or of the influence of external agents upon the organisms; but it is nevertheless inadmissible to formulate the problem in terms of a conception which falls without this whole system of principles and to say that, since the chemical and mechanical conceptions which we are now able to apply to organic development have proved inadequate to the statement of that process in its entirety, we must conceive it as autonomous and treat it in terms of entelechies. Autonomousness is a conception which falls without the domain of science altogether, because it applies to the thing only in its self-dependent totality—with which philosophy deals—and not to the thing in its relations to other things, as science must conceive it. Only in terms of their interaction can the empirical reason explain things at all; and in the case of organic development, as of all other processes, explanation must be through the determination of specific causal relations.

This mechanistic conception of science is of course a purely methodological assumption into which no ontological meaning is to be read. Its nature is misunderstood when, for example, it is called materialistic. The mechanistic conception applies to all facts which fall within the domain of science, whatever the metaphysical interpretation which may be given to them.

Robert MacDougall
New York University,
October 14, 1912

A PROTEST

To the Editor of Science: Permit me to offer an emphatic protest against the closing paragraph of Dr. Dorsey's letter in this week's Science (December 6). It is Dr. Dorsey's right, if conscience and judgment impel him, to express disapproval of missionaries in respect to either their purpose or methods or both, but to accuse them of "distortions," made from mercenary motives, is an utterly unjustifiable bit of spite. It not only reveals lamentable ignorance of facts, but betrays that intolerant and biased attitude of mind against which scientific men are supposed to particularly guard, and which in my judgment vitiates Dr. Dorsey's whole argument.

Hubert Lyman Clark

QUOTATIONS

THE EFFICIENCY NOSTRUM AT HARVARD

There has been a great deal of groping in the dark over the problem of raising the quality of our universities and colleges. But light has appeared at last. There will no longer be any futile casting about for improvements here and changes there, no more mere scratching of the surface. Somebody at Harvard has gone straight to the heart of the matter. Indeed, he has solved the whole problem in point of principle, though of course the details of the beneficent revolution he has started remain to be worked out. What has been needed all along has been some simple and yet profound guiding principle, and this is what the new move at Harvard supplies. See that you get your money's worth out of each professor—this is the philosopher's stone, which, firmly and steadily applied, is going to transmute into gold all the baser metal of our university faculties.

Seldom has a great reform been ushered in so noiselessly. "Harvard professors and instuctors," so goes a newspaper account, "are thoughtfully rubbing troubled brows to-day while they ponder over an intricate network of blanks and spaces whereon Assistant Controller Taylor has requested them to record the exact disposition which they make of all time spent in the interests of the university." The assistant controller states that he desires these data for the purpose of using them "as

a basis for pro-rating salaries to the various classified functions"; but, after supplying a formidable array of blanks to be filled with this end in view, he winds up with a request for information concerning "Contributory Activities," the giving of which is optional. These include the number of hours spent on "research work carried on personally by the instructor," and certain other things which, like this, "are of a quasi-private nature." The assistant controller recognizes that the variations in such data due to the personal equation "would make impracticable the direct use of these figures for the purpose of distributing salaries," but nevertheless he is apparently of the opinion that they would be a comfortable thing to have, and so he asks for them. And quite right, too; for the optional of to-day may be the compulsory of to-morrow, and it is well to "get a line" on these professor people, even if you can't pin them down to exact facts and figures.

In sober truth, this news from Harvard is a very serious matter. It touches the very vitals of the professor's calling. It ought to bring out from the Harvard faculty, and especially from the men of light and leading in that faculty, an impressive protest; and the most impressive form the protest could take would be that of a dignified but firm refusal to comply with the demand made upon them. For what is at stake at Harvard is nothing less than the whole character and status of the American professorate. To be a university professor has hitherto meant, in this country, as in all the world, to give to the university yourself—your personality, your talent, your capacity to interest, to instruct, to inspire. Many professors have, to be sure, fallen woefully short of fulfilling this ideal; many have been deficient in ability, many in character. But the one great thing that has made the calling attractive to the best who are in it has been that this was the plane on which it was understood to rest. It offers none of the glittering material rewards of other vocations; it seldom holds forth the allurement of fame. In this country, its dignity has been far below that which belongs to it in Europe, thanks to an exaltation of the idea of management and administration elsewhere unknown; but the recognition of the personal nature of the professor's work, of a distinctively personal measurement of his value, has never been abandoned. It is Agassiz, or Child, or Martin, or Gibbs, or Norton, or Gildersleeve—not so many hours of their labor—that Harvard, or Yale, or Johns Hopkins has had the good fortune to possess; and every faithful and competent professor has a right to feel that the same is true of him in his degree. But how long would that feeling survive under a system which required each professor to make report of every hour that he spent upon his work, and have his pay doled out to him accordingly?

It is easy to accuse those who object to the introduction of this efficiency nostrum of being reactionaries—upholders of the doctrine that whatever is is right. But it is still easier to reply to the accusation. Not because our universities and colleges are all that they ought to be, but because the proposed remedy is a crude and barbarous one, do we reject that remedy. We ought to have more competent teachers, we ought to have more inspiring leaders of research; but we shall not get them by means of time checks or card catalogues. The American professor is already far more subject to managerial control than his fellow in Germany or France; but it is in America, and not in Germany or France, that the cry of incompetent professors and inefficient instruction is continually heard. What is needed, above all things else, is to make the professorship attractive to superior men—men of originality, men of power, men of enthusiasm. When you have got all your time-card and efficiency-measure mechanism going, you may be able to compel every professor to come up to a certain standard; but you can not compel the men whom you ought to have as professors to enter the calling. You may get the same amount of "results" out of the faculties for less money, or a greater amount for the same money, so far as "results" can be measured by your mechanical methods; but what you have lost you will never be able to measure. And what shall it profit the uni-

versity to have gained countless student-hours and experiment-units and to have lost what is highest and best in it?

* * * * * *

President Lowell has sent to the members of the Harvard faculty a statement which amounts to something like a repudiation of the preposterous circular of inquiry issued several days ago in the name of the assistant controller of the university. A more complete repudiation would have been more welcome, but it should be safe to assume that Dr. Lowell's statement that "answers were intended to be wholly voluntary" and that "the recent circular was issued under a misunderstanding" means the end of this folly. The episode is one that Harvard should be glad to forget, except in so far as it drew out—as it did, though we are not informed as to what extent—threats of resignation on the part of men who had a proper conception of the professor's calling. It is humiliating to think that such a protest should have been made necessary at our country's most distinguished seat of learning; but as it has happened, we trust that the feeling of self-respecting professors has been made so manifest as to preclude the possibility of any resurrection of the foolish scheme.—New York *Evening Post.*

SCIENTIFIC BOOKS

Methods in Chemical Analysis Originated or Developed in the Kent Chemical Laboratory of Yale University. Compiled by FRANK AUSTIN GOOCH, Professor of Chemistry and Director of the Kent Chemical Laboratory in Yale University. 1912. New York, John Wiley & Sons; London, Chapman & Hall, Ltd. Pp. xii + 536. Price $4 net.

In his prefatory note the author states that "the object of this volume is to present the principal results reached by workers in the Kent Chemical Laboratory of Yale University in the investigation and development of methods in chemical analysis." As a rule, only those procedures are included which have been definitely proven to be useful, and the experimental data given are those immediately related to the facts stated. Copious references to original papers render further information regarding details, discussions and variations of procedure easily accessible if library facilities are available.

The subject matter is divided into twelve chapters, the first of which deals with "Appliances and General Procedure," the second with "The Alkali Metals," the third with the copper group, and so on, following the groups in the order of increasing valence across the periodic table.

The book is in no sense a text-book, nor is it of the character of a work for general reference with respect to methods of chemical analysis. It is, rather, a bringing together of abstracts of papers, all emanating from this laboratory so well and widely known for its contributions to chemical literature in this important field, but published in many journals throughout a long series of years. As such, it is a most remarkable compilation and can not fail to be of service to those in search of reliable analytical procedures, although its usefulness will be more like that of a "Beilstein" than that of a "Fresenius."

If it is recalled that the material is presented in concise, abstract form and yet occupies more than five hundred pages, it will be evident that the volume constitutes a striking tribute to the versatility and activity of Professor Gooch and his associates and a record which it would be exceedingly difficult for any other laboratory to parallel. The compilation is that of one who is a master in the art of clear, accurate and concise statement, but the compiler has characteristically repressed the evidences of his own share in the many investigations which made this volume possible. It is a book which should do much to uphold the "dignity of analytical chemistry," so warmly defended by the late Dr. C. B. Dudley, and one which may well incite others to renewed endeavor in this fundamental field of chemical science—a field which some have, of late, tended to regard as of inferior importance, but which happily shows signs of again asserting its claims to a fair share of recognition.

H. P. TALBOT

Introduction to the Rarer Elements. By PHILIP E. BROWNING. Third edition, thoroughly revised. New York, John Wiley & Sons. 1912. Pp. xii + 232.

Our knowledge of the rarer elements has been considerably extended since 1908, when the second edition of "Browning" appeared. While the general scheme of the work remains the same as in the two previous editions, the author has made many changes and additions throughout: for instance, the chapter on qualitative separation has been extended by including new analytical diagrams, working directions, and notes; the chapter on technical applications has been much improved by the addition of considerable material; and a table of spectroscopic lines and plates illustrating typical spectra have been added. The revision has been quite thoroughly done. For the first time the work has been well indexed; this improvement in itself greatly enhances the usefulness of the book.

Among the omissions may be noted the following: The test for the platinum metals (except osmium and ruthenium) devised by Curtman and Rothberg (this is the most delicate chemical test for platinum); and the conduct of the platinum metals toward various gases (Phillips, *Am. Phil. Soc.*, March 17, 1893).

It would be advisable in later editions to give the original references to the literature on technical applications, especially to the patents; and to include a complete bibliography of the treatises on the rarer elements, if any bibliography is given.

CHARLES BASKERVILLE

Light, Photometry and Illumination. A thoroughly revised edition of "Electrical Illuminating Engineering." By WILLIAM EDWARD BARROWS, JR., B.S., E.E., Professor of Electrical Engineering, University of Maine. New York, McGraw-Hill Book Company. 1912. Pp. ix + 335.

Some of the science, and most of the art, of illumination is still in a decidedly unsettled state, and he who wishes to write a text-book on the subject has a narrow course to sail between the Scylla of obsolescent matter and the Charybdis of controversial discussion. Professor Barrows apparently has more fear of the first danger; at any rate, he has in several parts of his new text gone perilously near to the second. A considerable part of the book is made up of quotations and passages adapted from recent papers. As a résumé of important articles of the last few years the work is useful, and its value is augmented by the care which has been taken to give references to the original authorities. By copious use of quotations the author to some extent disarms criticism and shifts responsibility to the original authors, but for purposes of instruction the book would be more valuable if some of the lengthy quotations were replaced by a digested presentation of the problems to be met and the facts supposed to be established.

The treatment of radiation which serves as an introduction to the book is characterized by a looseness of expression which can not fail to produce hazy ideas in the mind of the student. As examples may be mentioned the statement that "at wave-lengths greater than those of red light the energy radiated is in the form of heat" (p. 1), and the naïve criticism of the bolometer because it "is apt to indicate the heat rays rather than the luminous rays" (p. 93).

Even more serious are certain misstatements of fact, *e. g.*, "since the radiation varies as the fourth power of the temperature, it is evident that the greatest efficiency of radiation will be obtained at the highest temperatures," and "it follows from the above that the efficiency of the source as an illuminant will vary greatly with the temperature" (p. 4). These statements precede any mention of the real cause of the increase in efficiency, that is, the shifting of the radiation toward shorter wave-lengths with rise of temperature.

The discussion of the Luminous Equivalent of Radiation in Chapter III. is anything but clear. Its vagueness is due in part to the promiscuous use of terms without definitions,

but one can hardly avoid the conclusion that the author himself had no very sharply cut ideas associated with the various terms. It is to be regretted that the table of "reduced luminous efficiencies" taken from Ives is not accompanied by a quotation to explain the significance of this important conception and its relation to the older ideas of luminous efficiency and the mechanical equivalent of light.

On page 64 the statement is made that Houstoun's and Strache's specifications of a standard of illumination in terms of radiation having a spectral distribution corresponding to the sensibility curve of the normal eye "consist in specifying the light standard by the least quantity of radiated energy which can produce the standard intensity." This is not true, and the error is especially striking because immediately preceding it is a whole page of discussion of "the most efficient possible radiation" as the basis of the Ives standard.

It should be noted that the luminosity curves given on pages 42 and 98 are not in the form at present accepted, since they were plotted from Koenig's data without correction for the dispersion of his prism. Incidentally the ingenious hypothesis of Dr. Bell that errors in heterochromatic photometry with the equality of brightness photometer are due to "the shifting of colors by contrast along the luminosity curve" can not be considered so well established as the author seems to think.

In view of the importance of the relation of the old English candle to the international candle now generally accepted as the unit of intensity in England and France as well as the United States, it is unfortunate that Professor Barrows has felt it necessary to give a new value for the old unit (p. 61) and has thus helped to perpetuate the mistaken impression that the value of the English candle has been intentionally changed. The fact is that the present unit is exactly the same as the old English candle to the degree of accuracy with which the British authorities could determine the proper average value of the old unit. Since there have been no British standard sperm candles made under authority of law since 1898, and the German candle was superseded by the Hefner 25 years ago, it is to be hoped that makers of text-books will some time accept the simple ratios of units now in use and will cease to give confusing tables of uncertain historical ratios.

The middle portion of the book gives descriptions of a great variety of photometrical apparatus and a very complete exposition of various methods of calculating light flux and illumination. A number of tables summarize the published empirical data of the best-known illuminating engineers and are valuable as an approximate indication of the results to be expected from various types of illuminants and methods of installation. In an appendix are given several tables of constants which are useful in the calculation of illumination.

Two chapters devoted to principles of interior and of street illumination are largely quoted from papers of Mr. A. J. Sweet. Of 22 pages dealing with street lighting, 17 are copied verbatim. Since Mr. Sweet's papers were not intended to be text-books, it is no disparagement of his work to say that the chapter covers the subject very inadequately. That the opinions so fully quoted are not universally accepted is shown in a curious way. Mr. Sweet takes twelve pages to establish the conclusion that an angle of about 65° from the vertical "must be taken as a line of absolute prohibition" for high intensity in street lamps. "If it is to be exceeded at all, it may as well be entirely ignored," he says, and on the opposite page Professor Barrows gives a curve for a lamp which has 75 per cent. of its maximum candle-power as high as 80° from the vertical, with the statement that it "closely approximates the ideal conditions"!

The book as a whole would have been much improved by a thorough editing, for in many passages the language is crude, to say the least. It is marred also by an unusual number of typographical errors. Nevertheless, in spite of the many weak points, it must be granted that Professor Barrows has collected a large amount of valuable material, and it is to be hoped that future editions will enable

him to remedy defects both of form and of substance.

E. C. CRITTENDEN

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SPECIAL ARTICLES

THE EFFECT OF ANESTHETICS UPON PERMEABILITY

THERE is much uncertainty as to the mode of action of anesthetics and particularly as to their effect upon permeability. While some writers hold that anesthetics increase permeability, others take the opposite view.[1] To clear up this confusion appears to be a necessary step toward a theory of anesthesia.

A definite solution of this problem seems to have been attained in the cases here described. This result is due to the employment of quantitative methods without which it would not have been possible.

The experiments were made by measuring the conductance of living tissues of a marine plant, *Laminaria*. Under the conditions of the experiment an increase or decrease of conductance signifies a corresponding increase or decrease of permeability.[2]

The anesthetics were mixed with sea water and sufficient concentrated sea water was then added to make the conductivity equal to that of sea water. The material was then placed in the mixture and its conductance was measured at frequent intervals.

Material having resistance of 1,000 ohms[3] was placed in a mixture of 990 c.c. sea water plus 10 c.c. ether, to which was added sufficient concentrated sea water to make its conductivity equal to that of ordinary sea water. In the course of 10 minutes the resistance rose to 1,100 ohms: in the next 10 minutes it fell to 1,070 ohms; in 20 minutes more to 1,020 ohms, and in 20 minutes more to 1,000 ohms. In the next 20 minutes it dropped to 990 ohms, at which point it remained stationary for a long time. Subsequently it decreased very slowly, but at exactly the same rate as the control which remained in sea water during the experiment. After 24 hours it had the same resistance as the control.

In order to find out approximately[4] what part of the resistance is due to the living protoplasm the tissue was killed at the end of the experiment by adding a little formalin: after rinsing well in sea water the resistance was 320 ohms. This represents the resistance of the apparatus and dead tissue; on subtracting it from the resistance previously given we obtain approximately the resistance due to the living protoplasm. This may be called the *net resistance* while the resistance before subtraction may be called the *gross resistance*. In this experiment, therefore, the net resistance before treatment with ether was $1,000 - 320 = 680$ ohms and the net conductance $1 \div 680 = .00147$ mho. The loss in net conductance due to ether is 13 per cent., which means a decrease of permeability amounting to 13 per cent.

It is evident that this decrease of permeability is completely reversible and involves no injury. The fact that after the resistance has fallen to a stationary point it is 10 ohms below the starting point does not indicate injury, but only an increase in the conductivity of the solution due to the evaporation of the ether.

In another series of experiments the effects of the evaporation of the anesthetic were avoided by constantly renewing the solution by means of a steady current. It was then found that the resistance, after rising rapidly to a maximum, remained stationary for a long time (often for two hours or more) at the maximum point, afterward falling slowly to the normal. This more prolonged exposure to the anesthetic seemed to produce no injurious effects.

In these experiments the amount of ether in the solution was 1 per cent. by volume. Smaller amounts of ether produced less effect:

[1] Cf. Höber, "Physikalische Chemie der Zelle und der Gewebe," Dritte Auflage, 1911, pp. 219, 223, 489; R. Lillie, *Am. Jour. Physiol.*, 29: 372, 1912; 30: 1, 1912; Lepeschkin, *Ber. d. bot. Ges.*, 29: 349, 1911.

[2] The method has been described in SCIENCE, N. S., 35: 112, 1912.

[3] All the figures in this paper refer to readings at 18° C.

below 0.2 per cent. little or no effect was observable.

Higher concentrations of ether give a very different result. With 3 per cent. by volume of ether the resistance rises very rapidly to a maximum (which is about the same as when 1 per cent. is used) and then falls very rapidly. But instead of stopping when the normal is reached the resistance continues to fall rapidly until death ensues. If the concentration of ether be increased the period during which the resistance remains above the normal becomes shorter until finally it becomes impossible to detect it even when readings begin 30 seconds after placing the tissue in the anesthetic. There is a corresponding increase in the rapidity of the fall of resistance and of the onset of death.

The decrease of permeability observed in these experiments may be easily and quickly reversed by placing the tissue in sea water. Is this also the case with the increase in permeability? This was tested in the following manner: The material was allowed to remain in the anesthetic until its resistance had fallen about 100 ohms below the normal (*i. e.*, below the resistance it had before being exposed to the anesthetic). It was then replaced in sea water and readings were taken at frequent intervals; recovery would be shown by a rise in resistance.

No such rise in resistance was observed. The experiment was varied by replacing the tissue in sea water after the resistance had fallen only 50 ohms below the normal and also by choosing a concentration of ether which caused the resistance to fall very gradually. Even then there was but rarely any sign of recovery and this was of short duration and small in amount.

Similar results were obtained with chloroform, chloral hydrate and alcohol, but not at the same concentrations: the concentrations which correspond to 1 per cent. ether are approximately as follows: chloroform 0.05 per cent., chloral hydrate 0.05 per cent., alcohol 3 per cent.

Two distinct effects are observable in these experiments. One is a toxic effect evidenced by an increase in permeability, while the other involves a decrease of permeability. A very important question is, with which of these is the anesthetic action associated? Since the distinctive mark of an anesthetic is the reversibility of its action, it is not reasonable to suppose that this action is associated with an irreversible change in permeability. Such a change is in no way peculiar to anesthetics, but is common to all toxic substances. We are, therefore, forced to the conclusion that it is the reversible change, involving a decrease of permeability, which is associated with the anesthetic action.

The fact that typical anesthetics (ether, chloroform, chloral hydrate and alcohol) decrease the permeability of the tissue to ions is profoundly significant in view of the fact that the transmission of nervous and other stimuli is believed to depend on the movement of ions within the tissues.

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PARTIAL SEX-LINKAGE IN THE PIGEON

THAT certain characters in pigeons are sex-linked is shown by the work of Staples-Browne,[1] Cole[2] and Strong.[3] Both Staples-Browne and Strong, however, encountered certain exceptions which I shall try to show are explicable on the assumption that there is in the female pigeon a pair of sex-chromosomes, between which crossing-over of the factors may occur.

Staples-Browne found that a white female crossed to a dark male produced all dark offspring, showing that white is recessive to dark. The reciprocal cross, viz., white male by dark female produced dark males and white females. So far, this last cross is a typical case of "criss-cross" inheritance, in which the recessive character entered the cross from the parent homozygous for the sex-differentiating factor, viz., from the male in this case.

Staples-Browne found, however, in this F_1, in addition to the white females, one dark fe-

[1] R. Staples-Browne, *Jour. Genetics*, June, 1912.

[2] L. J. Cole, SCIENCE, August 9, 1912.

[3] R. M. Strong, *Biol. Bull.*, October, 1912.

male, and Strong found three such dark females.

If in the female the sex-differentiating factor and the factor for plumage color are placed close enough together in the same chromosome to be linked, but not so close that the linkage is complete, "crossing-over" would cause the two factors which entered in the same member of the homologous pair of chromosomes to lie in different members and hence to segregate to different gametes.

If the sex-differentiating factor be M, then the formula for the male is MM and for the female Mm. Let the gene carried by the recessive white pigeon be w and the dominant form of that gene carried by the dark bird be W. The dark female would ordinarily form gametes of the types MW and mw, but would occasionally form gametes Mw and mW by crossing-over.

The gametes and their possible combinations would be as follows:

P_1	White ♂	Mw—Mw
	Dark ♀	Mw—MW—mw—mW
F_1	$\frac{Mw}{Mw}$	— white ♂ (exceptional)
	$\frac{Mw}{Mw}$	— dark ♂
	$\frac{MW}{mw}$	— white ♀
	$\frac{Mw}{mW}$	— dark ♀ (exceptional)

A measure of the linkage between the sex-differentiating factor and the factor for plumage color would be the ratio of crossovers to the total number of individuals which might show crossing-over, viz., 4:59 or 7 per cent.

It should be pointed out that "partial-sex-linkage" signifies the linkage between the sex-differentiating factor and any other factor in the sex chromosome. In the case of *Drosophila* "sex-linked" means only that the factor is carried by the sex chromosome, and as yet no evidence has been obtained bearing on the degree of linkage of the sex-differentiating factor and any of the other factors thus far found in the same chromosome.

An explanation similar to the one here adopted for the pigeon may be given to Bateson and Punnett's[4] results with the silky fowl where partial-sex-linkage in the pigmentation is found. Three other cases of the same sort have been reviewed by Sturtevant,[5] viz., pink versus black eye in canaries, *Aglia tau* and its variety *lugens*, and *Pygæra anachoreta* and *P. curtula*.

Two cases of partial-sex-linkage in which the male is heterozygous for sex are reported. At least Sturtevant[6] so interprets the case of the dwarf guinea-pigs of Miss Sollas, and quite recently Doncaster[7] finds in cats that certain exceptions in the inheritance of coat-color may be due to partial-sex-linkage.

CALVIN B. BRIDGES
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EXPERIMENTS SHOWING THAT COMPLETE RELATIVITY DOES NOT EXIST IN ELECTROMAGNETIC INDUCTION

IN the *Physical Review* for November, 1912, I described in detail some experiments which, taken together with earlier experiments by Faraday and others, establish the fact that complete relativity does not exist in electromagnetic induction. As a number of enquiries with reference to these experiments have been made, and as the subject of relativity is one in which great interest is taken by others as well as physicists, it seems desirable to give a brief account of the experiments in SCIENCE.

Two series of experiments were made, one without iron and the other with iron. In the first series a cylindrical condenser was mounted symmetrically in the approximately uniform magnetic field within a cylindrical electric coil coaxial with the condenser's armatures. The condenser, maintained at rest, was short-circuited, and the coil, tra-

[4] W. Bateson and R. C. Punnett, *Jour. Genetics*, August, 1912.

[5] A. H. Sturtevant, *Jour. of Exp. Zool.*, May, 1912.

[6] A. H. Sturtevant, *Am. Nat.*, September, 1912.

[7] L. Doncaster, SCIENCE, August 2, 1912.

versed by an electric current, was rotated about its axis at uniform speed. The inner armature of the condenser was then insulated from the outer, after which the magnetic field was annulled and the rotation stopped. The inner armature was then tested for electric charge.

The second series of experiments was similar to the first except that the magnetic field was produced by two symmetrical electromagnets mounted *coaxially* with the condenser and rotated together at the same speed.

In neither series of experiments was there detected upon the condenser any charge as great as the experimental error (see below).

Now it is an immediate consequence of the classical experiments of Faraday and others upon the electromotive force developed in a metal disc rotating in a magnetic field produced by a *fixed* electric coil or magnet, together with experiments of Blondlot,[1] H. A. Wilson,[2] and myself[3] upon the electric charges developed on adjacent conductors by the motion of insulators in magnetic fields produced by fixed coils or magnets, that, if the complete condenser and its short-circuiting wire had been rotated while the coil or magnets remained fixed, the armature tested would have received a charge equal to the continued product of the capacity of the condenser as it would be with air or free ether as dielectric, the magnetic flux through the space between the armatures, and the number of revolutions of the condenser per second. Moreover, it follows from the above mentioned experiments on insulators that if the condenser's dielectric is air, as in my own experiments, it is of no consequence whether the air rotates with the armatures or not.

It was thus easy to calculate the charge which would have been developed upon the condenser in each of my experiments for the same relative motion between it and the complete field-producing agent, but with this agent at rest and the condenser in motion.

The investigation proved conclusively that the condenser system, when it remained at rest and the agent producing the field rotated, received not more than a minute fraction of the charge it would have received for the same relative motion if the agent producing the field had been the part to remain at rest. Within the limits of error of the experiments —about 1.4 per cent. in the experiments with the electric coil, and about 1 per cent. in the experiments with the electromagnets—this fraction was zero.

The experiments appear to be *experimenta crucis*, in complete accord with the theory of Lorentz, but inconsistent with any theory based on complete relativity.

S. J. BARNETT
THE OHIO STATE UNIVERSITY

[1] *Journal de Physique*, 1902.

[2] *Phil. Trans.*, 1904.

[3] *Physical Review*, 1908.

THE AMERICAN SOCIETY OF NATURALISTS

THE thirtieth annual meeting of the American Society of Naturalists was held at Case School of Applied Science, Cleveland, Ohio, on January 2, in connection with the meetings of the American Society of Zoologists, the American Association of Anatomists, the Botanical Society of America, the American Society of Physiologists, the American Society of Biological Chemists, the American Phytopathological Society, and the various sections of the American Association for the Advancement of Science.

The *morning* session was devoted to a symposium on Adaptation, with the following speakers:

M. M. Metcalf (Oberlin College): "The Origin of Adaptations through Selection and Orthogenesis."

Burton E. Livingston (Johns Hopkins University): "Adaptation in the Living and Nonliving."

George H. Parker (Harvard University): "Adaptation in Animal Reactions."

Henry T. Cowles (University of Chicago): "The Adaptation Viewpoint in Ecology."

Alfred G. Mayer (Carnegie Institution of Washington): "Adaptation of Tropical Animals to Temperature."

Albert P. Mathews (University of Chicago): "Adaptation from the Standpoint of the Physiologist."

Lawrence J. Henderson (Harvard University): "The Fitness of the Environment; an Inquiry

into the Biological Importance of the Properties of Matter.''

These papers will appear in the *American Naturalist.*

The afternoon session was for the reading of papers on Genetics, the program being as follows:

R. M. Strong (University of Chicago): ''Sex-linked and Sex-limited Inheritance.'' Read by title.

L. J. Cole (University of Wisconsin): ''The Reversionary Blue Pigeon.''

B. M. Davis (University of Pennsylvania): ''The Behavior of Hybrids of *Œnothera biennis* and of *Œ. grandiflora* in the Second and Third Generations.''

George H. Shull (Carnegie Institution of Washington): (1) ''Duplicate Genes for *Bursa bursa-pastoralis.*'' (2) ''A Sex-limited Character in Plants.''

R. A. Emerson (University of Nebraska): ''The Inheritance of a Recurring Somatic Variation in Variegated Ears of Maize.''

C. M. Child (University of Chicago): ''The Fundamental Reaction System and its Significance in Inheritance.'' Read by title.

A. F. Shull (University of Michigan): ''Inheritance of Egg Characters and the Sex-ratio in *Hydatina senta.*''

J. A. Detlefsen (University of Illinois) (introduced by W. E. Castle): ''Studies of a Cross between *Cavia rufescens* and the Guinea-pig.''

K. Foot and E. C. Strobell (New York City): ''Results of Crossing Two Hemipterous Species with Reference to the Inheritance of an Exclusively Male Character, and its Bearing on Modern Chromosome Theories.''

H. K. Hayes (Connecticut Agricultural Experiment Station): ''The Inheritance of Certain Quantitative Characters in Tobacco.''

The annual dinner of the society was held on the evening of January 2, at the Colonial Hotel, one hundred and twenty-four being present. The president's address by Professor E. G. Conklin, on ''Heredity and Responsibility,'' was published in SCIENCE for January 10.

The following new members were elected: Helen D. King, Wistar Institute; Lewis R. Cary, Princeton University; E. Newton Harvey, Princeton University; Ethel M. Browne, Princeton University; Aute Richards, University of Texas; Otto F. Kampmeier, University of Pittsburgh; C. G. Crampton, Massachusetts Agricultural College, Amherst, Mass.; H. F. Roberts, Manhattan, Kansas; F. W. Bancroft, Rockefeller Institute; Caswell Grave, Johns Hopkins University, and H. L. Wieman, University of Cincinnati.

The following officers were elected for 1913:

President—Ross G. Harrison, Yale University.

Vice-president—E. M. East, Harvard University.

Secretary—B. M. Davis, University of Pennsylvania.

Treasurer—J. Arthur Harris, Station for Experimental Evolution, Cold Spring Harbor.

Additional Members of the Executive Committee—A. P. Mathews, University of Chicago, and A. L. Treadwell, Vassar College.

A. L. TREADWELL,
Secretary for 1912

THE AMERICAN MATHEMATICAL SOCIETY

THE nineteenth annual meeting of the American Mathematical Society was held at Cleveland, Ohio, in affiliation with the American Association for the Advancement of Science, on Tuesday–Thursday, December 31–January 2. The usual winter meeting of the Chicago Section was merged in this annual meeting. Separate sessions of the society were held on Tuesday morning, Wednesday morning and afternoon and Thursday morning. On Tuesday afternoon there was a joint meeting of the society with Sections A and B of the American Association, the Astronomical and Astrophysical Society of America and the American Physical Society. At this joint meeting the following papers were read:

E. B. Frost, vice-presidential address, Section A: ''The spectroscopic determination of stellar velocities, considered practically.''

R. A. Millikan, vice-presidential address, Section B: ''Unitary theories in physics.''

A. G. Webster: ''Henri Poincaré as a mathematical physicist.''

E. J. Wilczynski: ''Some general aspects of modern geometry.''

L. A. Bauer: ''Cosmical magnetic fields.''

G. E. Hale: ''Preliminary note on an attempt to detect the general magnetic field of the sun.''

The attendance at the several sessions of the society included sixty-two members. The chair was occupied in succession by Professors E. W. Davis, E. H. Moore, G. A. Bliss, and after the annual election by the president-elect, Professor E. B. Van Vleck. The following new members were elected: E. W. Chittenden, University of Illinois; C. S. Cox, Mulberry, Fla.; S. D. Killam, University of Rochester; J. T. Rorer, Philadelphia, Pa.; R. M.

Winger, University of Illinois. Sixteen applications for membership were received.

At the annual election, which closed on Thursday morning, the following officers and other members of the council were chosen:

President—E. B. Van Vleck.
Vice-president—M. W. Haskell, B. O. Peirce.
Secretary—F. N. Cole.
Treasurer—J. H. Tanner.
Librarian—D. E. Smith.
Committee of Publication—F. N. Cole, E. W. Brown, Virgil Snyder.
Members of the Council—F. C. Ferry, W. B. Ford, R. C. Maclaurin, Jacob Westlund.

The treasurer's report shows a balance of $9,684.92, including the life membership fund of $4,483.69. Sales of publications during the year amounted to $1,730.94. The total membership of the society is now 680, including 64 life members. The total attendance of members at all meetings during the past year was 336, the number of papers presented 179. The library shows a marked growth, the number of catalogued volumes being now 4,560. Much of the increase is due to the generous gifts of several hundred volumes by Dr. Emory McClintock and Dr. G. W. Hill, ex-presidents of the society.

The following papers were read at this meeting:

R. D. Carmichael: "On the numerical factors of the arithmetic forms $\alpha^n \pm \beta^n$."

R. D. Carmichael: "On non-homogeneous linear equations with an infinite number of variables."

R. D. Carmichael: "Note on Fermat's last theorem."

W. A. Hurwitz: "Mixed linear integral equations of the first order."

H. Galajikian: "On certain non-linear integral equations."

W. A. Hurwitz: "On Green's theorem for the plane."

Arnold Emch: "On some properties of closed continuous curves."

G. A. Miller: "The product of two or more groups."

J. E. Rowe: "Three or more rational curves in collinear relation."

F. R. Sharpe and F. M. Morgan: "Quartic surfaces invariant under periodic transformations."

H. M. Sheffer: "A set of postulates for the Boolean algebra."

J. R. Conner: "The rational sextic curve and the Cayley symmetroid."

J. R. Conner: "Multiple correspondences determined by the rational space septimic."

L. E. Dickson: "Finiteness of the odd perfect and primitive abundant numbers with a given number of distinct prime factors."

L. E. Dickson: "Amicable number triples."

J. L. Coolidge: "A study of the circle-cross."

G. A. Bliss: "The relation satisfied by two dependent functions near a point at which both are singular."

J. A. Eiesland: "On the algebraic curves of a tetrahedral complex and the corresponding surfaces conjugate to it."

E. H. Moore: "On nowhere negative kernels."

Daniel Buchanan: "Oscillations near one of the isosceles triangular solutions of the three-body problem."

Peter Field: "On constrained motion."

G. C. Evans: "On the reduction of certain types of integro-differential equations."

J. A. Caparo: "Hyperspace and the non-euclidean geometry of four dimensions."

Jacob Westlund: "On the factorization of rational primes in cubic cyclotomic number fields."

E. L. Dodd: "An erroneous application of Bayes's theorem to the set of real numbers."

E. L. Dodd: "The validity of Bertrand's approximation leading to the probability integral."

Edward Kasner: "Equitangential trajectories in space."

C. J. Keyser: "Concerning multiple interpretations of postulate systems and the 'existence' of hyperspaces."

E. J. Wilczynski: "On a certain completely integrable system of linear partial differential equations."

L. C. Karpinski: "Algebra in the Quadripartitum numerorum of Johannes de Muris."

L. C. Karpinski: "Hindu numerals among the Arabs."

H. B. Phillips: "Directed integration."

Joseph Lipke: "Geometric characterization of isogonal trajectories on a surface."

J. B. Shaw: "Integral invariants of general vector analysis."

J. B. Shaw: "On non-linear algebras."

D. R. Curtiss: "Proofs of certain formulas suggested by Laguerre's work in the theory of equations."

Arthur Ranum: "On the projective differential classification of n-dimensional spreads generated by ∞^1 flats."

I. M. Schottenfels: "Proof that there is but one simple group of order $7!/2$."

L. P. Eisenhart: "Certain continuous deformations of surfaces applicable to quadrics."

E. V. Huntington: "A set of independent postulates for 'betweenness.'"

A. B. Frizell: "Some terms in the expansion of the infinite determinant."

T. H. Gronwall: "On Weierstrass's preparation theorem."

T. H. Gronwall: "On series of spherical harmonics (second paper)."

Cora B. Hennel: "Transformations and invariants connected with linear homogeneous difference equations and other functional equations."

Harris Hancock: "Problems in arithmetical geometry."

Harris Hancock: "Generalization of a theorem due to Liouville or to Dedekind, with applications to the geometry of numbers."

W. D. MacMillan: "A proof of Wilczynski's theorem."

W. D. MacMillan: "On Poincaré's correction to Bruns's theorem."

W. B. Fite: "Some theorems concerning groups whose orders are powers of a prime."

L. L. Small: "Some generalizations in the theory of summable divergent series."

C. E. Love: "On the asymptotic solutions of linear differential equations."

Virgil Snyder: "Algebraic surfaces invariant under an infinite discontinuous group of birational transformations (second paper)."

L. L. Silverman: "On the equivalence of definitions of summability."

R. M. Winger: "Self-projective rational curves of the fourth and fifth order."

The next meeting of the society will be held at Columbia University on Saturday, February 22.

F. N. COLE,
Secretary

THE OHIO ACADEMY OF SCIENCE

THE twenty-second annual meeting of the Ohio Academy was held at Ohio State University, Columbus, O., on November 28, 29 and 30, the president of the society, Professor Bruce Fink, of Miami University, presiding. On Thursday evening an informal reception was given at the Ohio Union Club, where assignment of rooms were made to the visiting members, and a pleasant social period was thoroughly enjoyed by all. The sessions on Friday and Saturday were in the general lecture room of the Physics Building.

The address of President Fink on "Botanical Instruction in Colleges" occurred at 1:30 P.M., Friday, while the evening was given up to a dinner and smoker.

The complete program follows:

"New and Rare Plants added to the Ohio List in 1912," J. H. Schaffner.

"Some Applications of Biometry to Agricultural Problems," A. G. McCall.

"The Influence of Topography on Bird Migrations," Lynds Jones.

"Experiments in Fertilization," R. A. Budington.

"Heredity (Eugenics)," W. F. Mercer.

"The Ohio Biological Survey," Herbert Osborn.

"Notes on some Rare Ohio Mosses," Clara G. Marks.

"Effect of Road Oil on Rubber Tires," Errol L. Fox and Chas. P. Fox.

"Notes on Ohio Oaks," W. R. Lazenby.

"The Mississippian-Pennsylvanian Unconformity and the Sharon Conglomerate," G. F. Lamb.

"The Primary Motor Column of the Central Nervous System of *Amblystoma* and its Relation to the Motor Nerves," C. E. Coghill.

"Note on the Tactile Reactions of some Orb-weaving Spiders in their Webs," W. M. Barrows.

"*Balanoglossus* and the Origin of the Central Nerve Tube in Vertebrates," M. M. Metcalf.

"Additions to the Cedar Point Flora," E. L. Fullmer.

"Seeds and Seedling of some Forest Trees," W. R. Lazenby.

"Lorain County Myxomycetes," F. O. Grover.

"The Cerebral Ganglia of the Frog Tadpole," F. L. Landacre and Marie F. McLellan.

"An Ancient Lake in Ohio with Unlevel Shorelines," Geo. D. Hubbard.

"Terraces associated with the Terminal Moraine near Delafield, Wisconsin," C. G. Shatzer.

"An Ecological Study of Forest Types near Columbus," F. B. H. Brown.

"Algæ of Lorain County, Ohio, with Notes on their Distribution," Susan P. Nichols.

"Yerba Mate (Paraguay Tea)," Chas. P. Fox.

"Mississippian Conglomerates in Northern Ohio," G. F. Lamb.

"Charts illustrating Feeble-mindedness," W. F. Mercer.

"A Supernumerary Appendage in *Otocryptops sexspinosus*, and a Theory of Heterorhythmic Development," L. B. Walton.

"The Soaring Flight of Birds," Lynds Jones.

"The Aquarium at the Naples Station," Stephen R. Williams.

"Geography of the Balkan Peninsula" (lantern slides), N. M. Fenneman.

"A Botanical Survey of the Sugar Grove Region" (lantern slides), Robert Griggs.

"The Fauna of the Conemaugh Formation," Clara G. Marks.

"A Preliminary Report on the Crayfishes of Ohio," C. I. Turner.

"Induced Modifications in the Pigment Development of Spelerpes Larvæ," A. M. Banta.

"Review of the Genus *Dero* (Aquatic Oligochates) with a Description of Two New Species," L. B. Walton.

"The Composition of a Typical Prairie," J. H. Schaffner.

"A List of Plants Collected in Cuyahoga County and New to the County or to Ohio," Edo Claassen.

"The Effects of Changes in Sea Beds on the Fauna and Lithology of the Richmond Period," G. M. Austin.

"The Application of Physics to Agriculture," A. G. McCall.

"The Resistance of Aluminum Oxide Films," H. E. Graber.

"The Differentiation of Diffraction Effects from the Extra Transmission of Electric Waves," C. R. Weinland.

"The Spectrum of Cored Carbons," C. D. Coons.

"The Effect of a Constriction in a Discharge Tube," R. F. Earhart.

"The Production of Light by the Firefly," C. R. Fountain.

"The Hall Effect and Allied Phenomena in Magnetic Alloys," A. W. Smith.

"Twist in Nickel and Steel Rods due to a Longitudinal Magnetic Field," S. R. Williams.

"The Effects of Temperature and Potential on the Thermionic Emission Heated Wires," Charles Sheard.

"The Scattering of Gamma Rays by Matter," S. J. Allen.

"Some Peculiarities of the High Frequency Graphite Arc," A. D. Cole.

DEMONSTRATIONS

Charts showing Distribution of Mitosis in the Central Nervous System of *Amblystoma* as Correlated with Functional Development, G. E. Coghill and S. W. Camp.

A Supernumerary Appendage in *Otocryptops sexspinosus* (Chilopoda), L. B. Walton.

Fine Crystals of Hopeite and of Tarbuttite, Two Rare Hydrous Phosphates of Zinc from Africa, Geo. D. Hubbard.

Maps and Diagrams Illustrating an Ecological Study of Forest Types, F. B. H. Brown.

The committee on the State Biological Survey reported that a definite organization had finally been accomplished through the cooperation of twelve educational institutions of the state and that a limited fund would at once be available toward beginning the work. The survey will be in charge of the director, Professor Herbert Osborn, of Ohio State University, and an administrative board consisting of a representative from each cooperating institution. The report was accepted and the committee dismissed.

The society adopted resolutions expressing its sense of loss in the death of three members during the year, Dr. Joshua Lindahl, Dr. P. A. Hobbs and Dr. H. L. True. Dr. Lindahl served the society as its president in 1900, and during his residence in Ohio had always taken an active interest in the success of the academy.

A resolution requesting legislation along the following lines was also adopted:

Resolved, that it is the sense of this academy that the legislature of Ohio should pass a law designed to make it impossible for the insane, the feeble-minded and the confirmed criminals to propagate their kind. That to this end we commend to its attention and study the laws providing for sterilization already in force in six of the United States. That copies of this resolution be sent to the several county and city medical societies of Ohio, asking their cooperation in the accomplishment of this purpose.

After adopting additional resolutions expressing the appreciation of the society for the courtesies extended by the faculty and others connected with the university, and furthermore thanking Mr. Emerson McMillan, of New York, for his continued donations to the research funds of the society, the academy adjourned to meet at Oberlin next November.

A department of physics was organized and 21 new members added, making the total membership 214.

The following officers were elected for the coming year:

President—Professor L. B. Walton, Kenyon College, Gambier, Ohio.

Vice-presidents—(Zoology) Professor Charles Brookover, Buchtel College, Akron, Ohio; (Botany) Professor F. O. Grover, Oberlin College, Oberlin, Ohio; (Geology) Professor August Foerste, Dayton, Ohio; (Physics) Dr. T. C. Mendenhall, Ravenna, Ohio.

Secretary—Professor E. L. Rice, Ohio Wesleyan University, Delaware, Ohio.

Treasurer—Professor J. S. Hine, Ohio State University, Columbus, Ohio.

Librarian—Professor W. C. Mills, Ohio State University, Columbus, Ohio.

Executive Committee—(ex-officio) Professor L. B. Walton, Gambier, Ohio; Professor E. L. Rice, Delaware, Ohio; Professor J. S. Hine, Columbus, Ohio; (elective) Professor S. J. Allen, University of Cincinnati, Cincinnati, Ohio; Professor C. G. Shatzer, Wittenberg College, Springfield, Ohio.

Board of Trustees—Professor W. R. Lazenby, Ohio State University, Columbus, Ohio.

Publication Committee—Professor J. H. Schaffner, Ohio State University, Columbus, Ohio.

L. B. WALTON,
Secretary

GAMBIER, OHIO,
December 4, 1912.

SCIENCE

FRIDAY, JANUARY 24, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

ATOMIC THEORIES OF RADIATION[1]

TWENTY years ago the system of theoretical physics seemed so complete as to justify the opinion, not infrequently expressed, that it was probable that the great discoveries in physics had all been made, and that future advances were to be looked for in the sixth place of decimals. And yet, in the very midst of these predictions, came the announcement, made just eighteen years ago this week, of Roentgen's discovery which showed that there were great mines of physical gold as yet unworked. Since that time discoveries of fundamental importance have followed one another with such amazing frequency that one who is at all familiar with the history of physics will scarcely challenge the statement that the past fifteen years is quite unparalleled in the number and the significance of its advances. At the present time, too, the air is full of suggestion of still more fundamental developments.

Most of these recent advances find a place under the general title, "The Triumphs of an Atomistic Physics." Within the past decade, the atomistic conception of matter has silenced the last of its enemies, and today we are counting the number of atoms and molecules in a given mass of matter with as much certainty and precision as we can attain in counting the inhabitants in a city. No census is correct to more than one or two parts in a thousand, and there

[1] Address of the vice-president and chairman of Section B—Physics—American Association for the Advancement of Science, Cleveland, December, 1912.

is little probability that the number of molecules in a cubic centimeter of a gas under standard conditions differs by more than that amount from 27.09 billion billion.

We have learned, too, a great deal about the insides of the atom. We have proved that it has electrical constituents, and that these also have an atomic structure. In other words, we have superposed upon an atomic theory of matter a much more fundamental and at the same time a much more simple theory of electricity. And we have found most convincing demonstrations of the correctness of the view that every electrical charge is built up out of an exact number of electrical atoms, and that every electrical current consists in some kind of a transport of these electrical atoms through the conducting body. In fact, we can now count the number of free electrons upon a small charged body as directly and as infallibly as we can count our fingers and toes.[2] We have measured, too, the exact value of this elementary electrical atom, and found it to be 4.774×10^{-10} absolute electrostatic units.[3]

Furthermore, we have added much to our knowledge about how atoms and molecules behave as aggregates. We have found the most convincing demonstrations, both quantitative and qualitative,[4] of the correctness of the fundamental assumptions of the kinetic hypothesis, and have proved experimentally that every molecule in a gas, whether of the size of the hydrogen unit or ten billion times as big, is endowed at a given temperature with exactly the same average kinetic energy of agitation. And we have measured with a fraction of a per cent. of accuracy the value of this universal constant.

Finally, we have tremendously extended our kinetic conceptions of matter through the study of radioactive processes, and have recently actually seen on photographic plates[5] the tracks of alpha and beta corpuscles as they shoot out spontaneously from radioactive atoms with speeds undreamed of in connection with projectiles of any kind twenty years ago—speeds which are of the same order of magnitude as the velocity of light.

In a word the last fifteen years have shown the atomic and kinetic conceptions to be certainly the most fruitful, may we not also say the most fundamental conceptions, not excepting even the principle of the conservation of energy, which have ever been introduced into physical science. Only in one domain have atomistic points of view failed completely to possess the field, and that, oddly enough, the only domain in which they were securely entrenched two hundred years ago, but from which they were driven, apparently forever, at the beginning of the last century, by the epoch-making work of Fresnel and Young. Upon this lost domain of *radiant energy* they are now making renewed attack. It is my purpose to-day to survey this field of conflict and to endeavor to appraise the successes and failures of each of the opposing forces from the point of view of *experimental* physics alone.

My first observation is that in this attack upon the domain of radiant energy, atomistic conceptions do not at present show a united front. In other words, there is not one sharply defined atomistic theory, but there are five distinct brands of "quantum" theory of various degrees of concentration. These are alike in that they all have to do with certain assumptions as to the nature of radiant energy, or as to the conditions under which such energy is ab-

[2] *Physical Review*, XXXII., p. 349, 1911.

[3] *Physical Review*, 1913.

[4] *Popular Science Monthly*, LXXX., p. 417, 1912.

[5] C. T. R. Wilson, *Proc. Roy. Soc.*, Vol. 87, p. 277, 1912.

sorbed or emitted by atomic or sub-atomic oscillators. Let us glance in succession at these various atomistic theories and inquire, first, what are the experimental facts which have called these five different types of assumption into being.

1. The first and least concentrated form, namely, that of Planck,[6] grew out of the fact that we had two radiation formulas, (1) that of Rayleigh,[7] and (2) that of Wien,[8] the first of which fitted the experimental facts for long wave-lengths (for which, indeed, it was alone suggested), while the second fitted the experimental curve at the other end of the spectrum only, although it was originally hoped that it would give the correct distribution of energy throughout the spectrum. Wien's general formula had been deduced from his displacement equation—an equation which rests only on thermodynamic reasoning and the proved facts of radiation pressure—with the aid of two additional assumptions, namely, (1) that the velocities of gas molecules follow the Maxwell distribution law; and (2) that the frequency of the vibrations sent out from a given molecule depends only on the temperature. Since this equation failed at long wave-lengths, and yet contained no more *particular* assumptions than those just mentioned, and since the first of these assumptions is one which we have the best of grounds for making, there was nothing to do but to modify the last one. Planck modified it in such a way as to obtain an equation that would go over into Rayleigh's equation at long wave-lengths, and into Wien's at short wave-lengths. I do not mean to imply that this sort of crass empiricism is all that there is behind Planck's equation. It is fair to point out, however, that this was the experimental situation which guided him in his search for a new radiation formula. His own argument is, in brief, somewhat as follows:

Boltzmann's identification of the concept of entropy in thermodynamics with the concept of probability in statistical mechanics, a step which Planck calls the "emancipation of the entropy concept from the limitations of man's experimental skill, and the elevation of the second law to a real principle," carries with it as a necessity not only the atomistic conception of matter, but also some sort of an atomistic conception of radiant energy. For the assigning of an exact numerical value to the probability of a given physical condition can be accomplished only by considering that condition as dependent on a finite member of equally likely possibilities or complexions. The greater the number of these complexions, the greater the value of the probability. For example, in the throwing of two dice, there are three equally likely complexions with which a throw of four dots can be realized, namely, a 3 with the first die and a 1 with the second, a 1 with the first and a 3 with the second, and a 2 with each. On the other hand, a throw of 2 dots can be realized through but one complexion, namely, a one with each. The probability, then, of a four-dot throw is just 3 times that of a two-dot throw. Now when the entropy of a physical condition is made to depend in this way on the probability of its occurrence, we see at once that entropy tends toward a maximum simply because a change to a new state will not take place unless that new state has a greater probability than the old one. But, says Planck, there is no way of making the appearance of a given physical condition in a system depend in this way upon a definite, countable number of

[6] "Vorlesungen über die Theorie des Wärmestrahlung," 1906, and "Acht Vorlesungen," etc., 1910.

[7] Rayleigh, *Phil. Mag.*, 49, p. 539.

[8] Wien, *Wied. Ann.*, 58, p. 662, 1896.

possibilities, except by conceiving the system to be made up of a definite number of concrete and definite elements—for a continuum can not have countable elements. Hence, an atomistic structure of the system is a fundamental condition for the representation of its entropy by a probability. All systems, then, which possess an entropy must possess an atomic structure. Now experiment justifies the carrying over of the entropy concept to an enclosure filled with radiant energy, for it is only in this way that the Stefan-Boltzmann law and the Wien displacement law, both of which are found experimentally to be correct, are deduced. Hence we are forced to conclude that an atomistic structure of some sort must be applied to radiant energy. Planck then proceeds to apply it as follows: He imagines an enclosure having perfectly reflecting walls to be filled with black-body radiation. In this enclosure, and in equilibrium with the black-body radiation, are linear electromagnetic oscillators of a given frequency ν. The relation between the energy U_ν in each oscillator of frequency ν, and the energy per unit volume u_ν of black-body radiation of frequency ν, is given by the ordinary electrodynamic laws as,

$$U_\nu = \frac{c^3}{8\pi\nu^2} u_\nu.$$

in which c represents the velocity of light. Now let us call in the idea of *atoms of energy* and assume that each oscillator contains at each instant an exact multiple of an element of energy ϵ. From a consideration then of the total number of oscillators, and the total number of energy elements in all the oscillators, we can obtain an expression, as in the case of the dice, for the total number of complexions of the system, that is, the total number of possible distributions of the energy elements among the oscillators. This leads to an expression for the entropy of the system of the form

$$S = F\left(\frac{U}{\epsilon}\right).$$

But the second law of thermodynamics, as applied by Wien,[9] had shown that

$$S = F\left(\frac{U}{\nu}\right).$$

Hence we must place $\epsilon = h\nu$, that is, the energy element ϵ is proportional to the natural frequency ν of the oscillator, and the proportionality factor h is a universal constant, which Planck calls the *Wirkungs quantum*. He thus arrives at his celebrated formula for the relation between the density of black-body radiation and frequency, namely,

$$u_\nu = \frac{8\pi h\nu^3}{c^3} \cdot \frac{1}{e^{h\nu/ckT} - 1}$$

or the intensity E_λ of black-body radiation of wave-length λ, and temperature T, is

$$E_\lambda = \frac{2c^2h}{\lambda^5(e^{ch/k\lambda T} - 1)}.$$

This formula meets the requirements of passing over, at small values of λT, into Wien's equation, namely,

$$E_\lambda = \frac{2c^2h}{\lambda^5} e^{-\frac{ch}{k\lambda T}},$$

and for large values of λT, into Rayleigh's equation, namely,

$$E_\lambda = \frac{2ckT}{\lambda^4}.$$

To this brief sketch of the origin of Planck's equation should be added the statement that Planck[10] finds a further proof of the necessity of taking some such step as that which he has taken in the faultlessness of Jeans's logic[11] in showing that the Hamiltonian equations, combined with the theory of probability, lead inevitably to Rayleigh's radiation equation, which is contradicted by experiment. There is,

[9] Wien, *Wied. Ann.*, 52, p. 132, 1894.

[10] Planck, *Ann. der Phys.*, 31, p. 758, 1910.

[11] Jeans, *Phil. Mag.*, 18, p. 209, 1909.

then, nothing whatever to do, in his judgment, except to deny the general validity of the Hamiltonian differential equations, and this is precisely what he has done. Furthermore, the fact that his own equation goes over into Rayleigh's equation when h is made infinitely small, seems to him to show decisively that certain elementary radiation processes, which in Jeans's theory are assumed to be continuous, are in fact discontinuous.

Now it would be presumptuous in me to attempt to pass upon the cogency of these arguments, especially as they have been made the subject of review by the foremost of the world theorists, among them the late Poincaré.[12] Nevertheless I shall pause just long enough to express the inevitable point of view of every man who has worked long enough in a laboratory to know from painful experience how large is the entropy, *i. e.*, the probability of the event, that *experimental* results will come out differently from the way in which, according to the inevitable logic of things, they must come out, and that for the reason that in five cases out of ten, the inevitable logic of the experimentalist, at least, involves some undiscovered or unconsidered element. He is prone to wonder, therefore, whether even the theorist's inevitable logic is absolutely inevitable.

However, it should be said that Poincaré,[12] while stating that the assumption that physical phenomena do not obey laws expressible by differential equations would constitute the most profound revolution which physics has undergone since Newton's day, yet sees no way of escape from Planck's conclusion, unless it be found in the fact that to obtain the relation between his linear oscillator and the density of black-body radiation, Planck assumes the very electrodynamic laws the validity of which he in the end denies. While this is indeed a weakness in his theory, it doesn't in any way affect his argument for the necessity of some such step as that which he has taken. To my own mind, the uncertainty in this last argument lies in the fact that the general validity of the law of equipartition of energy is assumed to be a necessary consequence of the Hamiltonian equations. If this be so, then the Hamiltonian equations certainly must go, for we have known for over thirty years that the law of equi-partition can not have any general validity.

Planck has appreciated fully from the beginning the above-mentioned weakness in the method of development of his equation, and within a year[13] he has modified his statement of his theory in the endeavor to meet Poincaré's objection. The theory as outlined above implies that, since energy is always contained in the oscillator in exact multiples of an energy unit, both the absorption and emission of energy by the oscillator must take place in units—that is discontinuously. Planck now assumes that emission alone takes place discontinuously, while the absorption process is continuous. At the instant at which a quantity of energy $h\nu$ has been absorbed, an oscillator has a chance of emitting the whole of its unit, a chance which, however, it does not necessarily take. If it in this way misses fire, it has no other chance until the absorbed energy has arisen to $2h\nu$, when it has again the chance of throwing out its 2 whole units, but nothing less. If again it misses fire, its energy rises to $3h\nu$, $4h\nu$, etc. The ratio between the chance of not emitting when crossing a multiple of $h\nu$, and the chance of emitting, is assumed to be proportional to the intensity of the radiation which is falling upon the oscillator. This, then, is at present the most fundamental and the least revolutionary form of quan-

[12] *Journal de Physique*, Se. 5, Vol. 2, p. 5, 1912.

[13] Planck, *Ann. der Phys.*, 37, p. 642, 1912

tum theory, since it modifies classical theory only in the assumption of discontinuities in *time*, but not in *space*, in the emission (not in the absorption) of radiant energy.

When we lay aside all consideration of the origin of this theory, and ask for its experimental credentials, we find two great successes commonly attributed to it, (1) it gives a correct energy-distribution curve; (2) it enabled Planck to deduce from radiation constants a value of the elementary electrical charge which agrees within its own limits of uncertainty—about 4 per cent.—with the values obtained by other and more accurate methods. The first of these claims is apparently justified, though too much stress must not be laid upon it in view of, first, the origin of the equation, and, second, the fact that from the shortest observable wave-lengths, clear down to the longest visible red, Wien's equation also fits the facts perfectly for all temperatures up to those of the arc. In other words, from the experimentalist's standpoint Planck's equation may be considered as Wien's equation with but a small correction term applied to it at one end. Such correction terms can often be obtained from a great variety of assumptions.

The second claim can not be considered at all, since the deduction of the value of e from the radiation constants has nothing whatsoever to do with quantum theory. The result comes just as well from Rayleigh's equation[14] as from Planck's and the significance of the fact that the correct value of e is obtained is that for certain ranges of temperature the kinetic energy of an oscillator in equilibrium with a gas is indeed the same as the translational kinetic energy of a gas molecule. Further successes of Planck's theory will be considered after the discussion of the other atomistic theories of radiation.

2. The second of these theories is somewhat more radical than the first, and is, in fact, merely that originally proposed by Planck. It assumes that both emissions and absorption of energy are discontinuous in time. Despite the fact that Planck has renounced this point of view, the theory refuses to die. Nernst and most of the investigators who are working in specific heat relations still adhere to it. What is the experimental situation which seems to demand it? It is a situation brought about by the recent development of methods of studying specific heats at high and low temperatures. I refer especially to the liquefaction of hydrogen and helium. Let us consider first the simplest case, namely, that of the specific heats of gases.

One of the most brilliant triumphs of the kinetic theory was the prediction that the molecular heat of a monatomic gas should be 2.98 calories, or approximately 1 calorie per degree of freedom of the molecule, a prediction accurately verified by experiment. Next, the theory said that the molecular heat of a more complex gas should be as many calories as its molecule has degrees of freedom. If then the molecule of a diatomic gas acts like a rigid frictionless dumbbell, no energy whatever going into vibrations along the line of connection of its two atoms, or into rotations about this line as an axis, then its degrees of freedom should be three translational, and two rotational, and hence its molecular heat should be 5 calories, which is, as a matter of fact, the value found for all of the so-called permanent diatomic gases at ordinary temperatures.

Now, however, come the facts which call for some modification of the simple dynamical theory. We have long known that even at ordinary temperatures the molec-

[14] Einstein, *Ann. der Phys.*, 17, p. 132, 1905.

ular heats of gases like chlorine and bromine, which have more loosely connected atoms than have the so-called permanent gases, are nearly a calorie too high; that, further, they grow higher as the temperature rises. Recent work,[15] too, shows that as the temperature is slowly raised from 300° to 1,200° C. the molecular heats of all the permanent gases rise from 5 to 6 calories, while at the temperature of 2,000° C. they have gone up to nearly 7, just as though two new degrees of freedom had gradually been added. This we should expect if at high enough temperatures energy begins to go into vibrations of the atoms along their line of connection in the diatom. Very recent work,[16] too, which seems to be reliable, shows that when the temperature of the diatomic gas H_2 falls from 200° absolute to 60° absolute, its molecular heat falls from 5 calories to 3 calories. In other words, at 60 degrees absolute, and presumably at lower temperatures, H_2 acts like a monatomic gas.

Now, say the quantum theorists, all these facts are beautifully explained by our hypothesis. For, according to it, no atomic vibrator can absorb any energy at all except in whole units of size $h\nu$, or multiples of $h\nu$. The diatomic vibrator then, consisting of the 2 atoms of a diatomic gas, can absorb no energy at all from the molecular impacts experienced by the molecule as a whole, until the energy of these impacts exceeds $h\nu$. Then it begins to absorb, and as the temperature rises still farther the number of atomic vibrators which begin to take on an energy load increases as rapidly as it can in view of the limitations imposed by the law of distribution of energy among the molecules, and the necessity of absorbing only in whole multiples of $h\nu$. In the end, as the temperature rises, each atomic vibrator takes on the share of the energy which properly belongs to it in accordance with the law of equi-partition. The atomic vibrators of the chlorine and bromine molecules begin to do this at lower temperatures than those of the other diatoms, because the bonds holding the chlorine and bromine atoms together are relatively weak, and consequently their *frequencies* are small. Hence the energy units $h\nu$, characteristic of these absorbers, are correspondingly small, and therefore the temperature at which the kinetic energy of the molecular impacts reaches this value is low.

The explanation of the fact that H_2 acts like a monatomic gas at low temperatures is this. The two rotational degrees of freedom of the H_2 molecule drop out at low enough temperatures, for the reason that these rotations correspond at a given temperature to a definite *mean* rotational frequency ν, and when the energy of impact falls below this value of $h\nu$ no energy can go into these rotations.

Coming now to the atomic heat relations of solid bodies, these have been much studied of late and are interpreted by Nernst and others in terms of this same form of quantum theory. Dulong and Petit's law of the equality of the atomic heats of the elements, and Kopp's law of the additive properties of atomic heats in compounds, were, until very recently, the most suggestive of the unexplained laws of experimental physics. Boltzmann[17] gave a fascinating interpretation of these relations by assuming that the atoms of solids have natural periods of vibration, and, if so, that they must be in thermal equilibrium with a gas when their mean vibratory kinetic energy is the same as the mean translational energy of the gas molecules. If this

[15] Nernst, *Zeit. f. Elek. Chem.*, 17, p. 272, 1911.

[16] Euken, *Ber. der Preuss. Akad.*, February, 1912, p. 141.

[17] Boltzmann, *Wien. Sitz. Ber.*, 63, 2 abt., p. 731.

be so the total energy content of an atom of a solid, in view of its three potential and three kinetic degrees of freedom, must be twice that of a molecule of a monatomic gas. In other words, the atomic heats of solids should be twice the molecular heats of monatomic gases, *i. e.*, they should be 6 calories, as in fact they are in most cases found to be. But brilliant and successful as was this stroke, it only made the abnormally small values of the atomic heats of the elements of low atomic weight (C, Bo, Si) the more inexplicable, especially after it was found that these substances all behave normally at high enough temperatures. Now the recent work of a number of experimenters, notably of Nernst[18] and his pupils, shows that at sufficiently low temperatures *all* substances show abnormally low atomic heats, and that, in general, the lower the atomic weight, the higher the temperature at which the abnormality begins to appear. This means that if a degree of rise in temperature means a given increase in the energy of vibration of the atoms of any substance, then at low enough temperatures only a fraction of the atoms take on their normal energy load. But this is precisely what the quantum theory demands. No atom can take on any energy at all until the impacts of the molecules of the surrounding gas possess an energy as high as $h\nu$, and hence the higher the ν the higher the temperature at which energy can begin to be absorbed. Further, *ceteris paribus*, the smaller the atomic weight, the higher the ν and hence the sooner, with decreasing temperature, should atomic heats lower than 6 calories begin to appear.

One can not withhold his admiration from the beauty of the qualitative agreement between this theory and experiment. But can the theory stand a quantitative test? Such a test has been made as follows. Lindemann,[19] by assuming simply that a fixed relation holds at the melting point, T_s, of any substance between the amplitude of its atomic vibrations and the distance between its atoms, that is, its atomic volume, v, obtained without the aid of a quantum theory, a formula of the form

$$\nu \propto \sqrt{\frac{T_s}{mv^{\frac{2}{3}}}},$$

by which the frequency ν in the solid state of an atomic vibrator of atomic weight m can be computed. This formula yields results which agree fairly well with direct measurements of ν by means of "reststrahlen" wherever the latter have thus far been made. With the aid of this formula, then, we may first check our rough guess that the order of diminishing frequencies is the exact order in which atomic heats begin with decreasing temperature to fall below 6 calories, and, second, we may compare the frequencies computed by Lindemann's formula with those given by Planck's equation and the observed departure from Dulong and Petit's law at low temperatures. The method of doing this was pointed out by Einstein.[20] The agreement is sufficiently good to warrant the conclusion that the departures from Dulong and Petit's law are in fact fundamentally conditioned by atomic frequency. But it can not be said that Planck's equation, as applied by Einstein to the computation of the relation between atomic heats and temperatures, succeeds in predicting very accurately the observed curves.[20] Furthermore, the departures are in the same direction with all substances. They may be explained by introducing additional hypotheses into the quantum theory, as Nernst and Lindemann have

[18] Nernst and Lindemann, *Sitz. Ber. d. Preuss. Akad.*, XIII., p. 306, 1910.

[19] F. A. Lindemann, *Phys. Zeit.*, 11, p. 609, 1910.

[20] Einstein, *Ann. der Phys.*, 22, p. 180, 1907.

sought to do,[21] or by seeking for causes of these specific heat relations which have nothing to do with quantum theory. The one conclusion which this experimental work in atomic heats drives home is that the principle of equi-partition of energy, while valid when applied to atomic vibrators for certain ranges of temperature, has no general validity. This is, however, nothing new. If we can not get rid of it without a quantum theory, as Planck and Poincaré and Jeans all imply, then some form of quantum theory has been demonstrated to be a necessity. If these atomic heat experiments stood alone, however, I fancy that other and more easily visualizable explanations would be sought. For example, so far, they seem to be qualitatively consistent with an assumption like this, namely, that as the absolute zero is approached, the atoms begin to freeze together, and thus the number of effective carriers of energy is diminished. The higher the atomic frequency the higher the temperature at which this freezing-up process begins. The atoms of solids would then be imagined to freeze into rigid systems of continually increasing size, each system being endowed, however, with the kinetic energy of agitation appropriate to its temperature. It might then become possible, before absolute zero was reached, for the total kinetic energy content of the whole mass to become that of a single molecule of the surrounding gas. Such an hypothesis would seem to account well for the exceedingly high thermal conductivity of non-metals at low temperatures,[22] since the transfer of energy from point to point would be effected by a diminishing number of intermediaries as the temperature fell. If, however, a quantum theory must be called in to account for phenomena in other fields, it is of course in the interest of simplicity to make it do service in the field of atomic heats as well. All that can now be said is that the attempts thus far made to apply it quantitatively in this field have not been particularly successful, though they have been sufficiently suggestive to stimulate to further experimenting. New data are sure to pour in rapidly in the near future.

3. We now come to the forms of atomistic theory which make radical assumptions regarding the distribution of radiant energy in *space*, rather than in *time*. The least radical of these, because the least general, is that of which Professor Bragg[23] is the most active exponent. It is frankly corpuscular. It was developed, however, with a view of explaining the properties of one type of radiation only, namely, X- and γ-rays, and at a time when there was some justification for regarding these as isolated phenomena. Recent developments have strongly emphasized the similarities, rather than the differences, between these and other types of so-called ethereal radiations. But this in no way weakens the positive arguments for a corpuscular form of X-ray. The most compelling of these arguments is as follows:

X-rays unquestionably pass over, or pass all but an exceedingly minute fraction of the atoms contained in the space traversed, without spending any energy upon them or influencing them in any observable way. But here and there they find an atom from which they hurl an electron with enormous speed. This is the most interesting and most significant characteristic of the X-ray, and one which distinguishes it from α- and β-rays just as sharply as does the property

[21] Nernst and Lindemann, *Zeit. für Elektrochemie*, 17, p. 867, 1911.

[22] Euken, *Ann. der Phys.*, 34, p. 185.

[23] Bragg, "Studies in Radioactivity," 1912.

of non-deviability in a magnetic field. For neither α- nor β-rays ever eject electrons from the matter through which they pass with ionizing speeds. The energy which the X-ray or the γ-ray imparts to its chosen electron has been conclusively shown by many observers to be altogether independent of the intensity of the X-rays, and also independent of the nature of the atom from which the electron is hurled.[24] It depends solely upon the penetrating power, or hardness, of the X-ray. In fact, there is strong evidence now for the statement that although only a thousandth part of the energy of the cathode-ray beam in an X-ray tube is transformed into X-rays at the anticathode, yet when these same X-rays, weak in energy as a whole, fall upon matter outside the tube, they eject electrons from it with energies as great or nearly as great as those of the individual electrons of the original cathode rays.[25] It is as though the same energy were passed on in new form whenever an X-ray produces a β-ray, or a cathode-ray, an X-ray. These facts seem to be completely inexplicable on any sort of a spreading wave theory. The assumption of a continuous absorption by an atom of X-ray energy until the atom accumulates a sufficient store to eject an electron with the observed speed is completely untenable, for the time required for it to do this, according to the spreading pulse theory, would be longer than the life of any X-ray bulb, yet as a matter of fact this ejection begins the instant the X-ray bulb is started. Precisely the same argument holds for γ-rays. For these are found to eject electrons from matter through which they pass with .9 the velocity of light. This corresponds to an energy of 7×10^{-7} ergs. According to Rutherford, the total energy of the γ-rays per gram of radium is 4.7×10^{-4} ergs, and if we assume that the number of γ-ray pulses is the same as the number of β-rays emitted, namely, 7×10^{10}, then the whole energy in a γ-ray is very nearly 7×10^{-10} ergs, *i. e.*, it is precisely the same as the energy communicated by the γ-rays to the ejected electron even though this ejection may happen at a distance of 50 or 100 meters from the source. There is then no escape from the assumption in the case of X-rays, nor in the case of γ-rays, unless it be found in the uncertainty of the assumption of the identity of the number of γ-ray pulses and the number of β-rays, that the emitted energy keeps together as an entity, or quantum, which may be transformed back and forth between a β-ray and an X- or γ-ray. This energy is slowly dissipated into heat in its passage through matter while it is in the form of a β-ray, but apparently not at all while in the form of an X- or γ-ray. This argument is so close to the undeniable experimental facts, at least as they now stand, that if X- and γ-rays stood by themselves it is probable that there would be few opponents to Bragg's theory as to the corpuscular nature of these rays. His actual assumption is that X- and γ-rays consist of neutral doublets whose velocity determines the hardness of the ray. This is an assumption the truth or falsity of which could be tested if we could find the speed of X-rays. Opinion is still divided, however, as to the validity of conclusions drawn from the attempts that have been thus far made to identify the velocity of X-rays with the velocity of light.[26] Even

[24] Innes, *Proc. Roy. Soc.*, LXXIX., p. 442; Sadler, *Phil. Mag.*, March, 1910; Bestelmeyer, *Ann. d. Phys.*, 22, 429.

[25] Bragg and Madsen, *Phil. Mag.*, May and December, 1908; Whiddington, *Proc. Roy. Soc.*, 1911 and 1912.

[26] Marx, *Ann. d. Phys.*, 33, p. 1305, 1910, and Franck and Pohl, *Ann. d. Phys.*, 34, p. 936, 1911.

though these two velocities should be definitely proved to be the same, Bragg's argument for some sort of a corpuscular theory of X-rays would still stand.

But, aside from the minor difficulty of accounting for the so-called polarization of X-rays, that is, the dissymmetry of their emission about the point at which they originate, Bragg's theory encounters the supreme difficulty of accounting for the rapidly growing evidence of a complete parallelism between optical and X-ray effects. Thus:

(1) Ultra-violet light, like X-rays, ejects electrons with speeds which have been repeatedly shown to be completely independent of the intensity of the source. I have myself raised a doubt about this conclusion, but have recently shown that the doubt is unjustified,[27] and that the conclusion holds even when the intensity varies in the ratio 1,000 to 1.

(2) In the normal photo-electric effect, which has none of the earmarks of a resonance phenomenon, all observers now agree that the speeds of the ejected electrons increase regularly with the frequency of the light,[28] just as the speeds of electrons ejected by non-homogeneous X-rays increase with the hardness of the rays. Apparently, too, the law of increase is the same in each case.

(3) There is a selective photo-electric effect characterized by the emission at a particular frequency of the exciting rays of an abnormal number of electrons. This emission can not be excited until the frequency of the incident light reaches a definite value which is characteristic of the illuminated substance. This selective effect bears all the earmarks of an absorption band.[29] Precisely similarly there is a selective X-ray effect characterized by the emission at a given hardness of an abnormal number of electrons, and also by the excitation of a new type of X-ray radiation, which differs from the ordinary or scattered X-ray in being homogeneous, symmetrical about the origin, and having a penetrating power which is characteristic of the emitting substance instead of the quality of the exciting X-ray. This so-called homogeneous or characteristic X-radiation can not in general be excited until the hardness of the exciting ray exceeds a definite value. This critical value is nearly proportional to the atomic weight of the excited substance. The exciting rays experience absorption at the hardness at which the new increase in β-ray emission occurs. In other words, this selective X-ray effect, like the selective photo-electric effect, bears all the earmarks of an absorption band.[30]

(4) Light rays, X-rays and γ-rays all behave exactly alike in throwing more electrons forward in the direction in which the rays are moving than backward in the direction from which they came.[31]

(5) Finally, Laue, Friedrich and Knipping,[32] by using as a diffraction grating the regular arrangement of the molecules themselves in a crystalline substance, have recently obtained beautifully sharp photographic patterns which resemble very closely diffraction patterns in light. The wave-lengths of the X-rays computed from assumed intermolecular distances is about

[27] *Physical Review*, January or February, 1913.

[28] E. Ladenburg and K. Markan, *Phys. Zeit.*, 9, p. 821; Hughes, *Phil. Trans.*, CCXII., p. 205, 1912.

[29] Pohl and Pringsheim, *Verh. d. D. Phys. Ges.*, 1911 and 1912.

[30] Barkla and Sadler, *Phil. Mag.*, May, 1909; Sadler, *Phil. Mag.*, March, 1910; Whiddington, *Proc. Roy. Soc.*, 1911 and 1912.

[31] Bragg, "Studies on Radioactivity"; Kleeman, *Proc. Roy. Soc.*, 84, p. 93, 1910; Stuhlmann, *Phil. Mag.*, 20, p. 331, 1910; and Robinson, *Phys. Zeit.*, 13, p. 276, 1912.

[32] *Münch. Ber.*, pp. 303–322, 1912.

10^{-9} centimeters, or .0001 that of the shortest known ultra-violet waves. These experiments present strong evidence that some types of X-rays at least possess a periodic character. In a word, then, all these similarities suggest inevitably the hypothesis that ordinary scattered X-rays are white light, of short wave-length, and that characteristic X-rays are monochromatic light of short wave-length. If Bragg's neutral pair theory is to have any future, it must in all probability, then, be extended to all electro-magnetic radiations.

But how, when a charged pitch ball, for example, swings back and forth on its silk-thread suspension in our laboratories, are the periodic electromagnetic disturbances which it sets up in the neighborhood to be interpreted in terms of the emission of neutral pairs? No one is bold enough at present to attempt to thus resurrect a straight corpuscular theory of all ethereal radiation, with all that it implies regarding the dependence of the velocity of light, on the velocity of the source, the interpretation of interference phenomena in light and of Hertz's wave phenomena in the realm of wireless telegraphy. We need, then, a more general hypothesis than that of Bragg.

4. Such a general hypothesis was made by J. J. Thomson in his Silliman lectures in 1903.[33] It was, historically, the first form of the modern atomistic theories of radiation as regards space relations, although it is here treated in the fourth place, because it stands fourth in the violence of the assumptions involved. Like Bragg's theory, it postulates radiant energy which is emitted by the source in bundles or quanta, though no necessary multiple relationship was at first assumed between the different elements emitted by the same source. It goes farther than Bragg's theory in endeavoring to reconcile this quantum notion with the wave theory by assuming a fibrous structure in the ether, and picturing all electromagnetic energy as traveling along Faraday lines of force conceived as actual strings extending through all space. This is nothing more than a new picture of the structure of the ether and one which is perhaps no more impossible than all its rivals. To the support of such a hypothesis are brought all the arguments urged for Bragg's theory, while the arguments which I have urged against Bragg's theory are removed. It may be difficult, not to say repugnant, to some of us to attempt to visualize the universe as an infinite cobweb spun by a spider-like creator out of threads that never become tangled or broken, however swiftly electrical charges may be flying about or however violently we enmeshed human flies may buzz, but such is the hypothesis, and the objections to it will be treated along with those of the next and most concentrated form of quantum hypothesis.

5. This was proposed by Einstein[34] in 1905, and is simply the J. J. Thomson theory of the discontinuous distribution of radiant energy in space, assumed still to be electromagnetic and hence to have a velocity independent of that of the source, with the addition of Planck's original assumption that a given source emits and absorbs energy in units which are multiples of $h\nu$. This amendment has apparently been accepted by Thomson and seconded by Larmor. For the energy units, $h\nu$, have had some experimental successes, the consideration of which it was thought best to defer to this point.

In the normal photo-electrical effect the kinetic energy of the escaping electron increases with the frequency of the incident

[33] "Electricity and Matter," pp. 63 et seq.

[34] *Ann. der Phys.*, 17, p. 132, 1905.

light, and the experimental evidence is now fairly strong, especially in view of the recent work of Hughes,[35] that it is directly proportional to ν. This is what we should expect from the fact that the energy of an electron ejected by an X-ray is proportional to the energy of the cathode particle which produces the X-ray. For the ether disturbance set up by stopping a cathode particle corresponds exactly to the ether disturbance set up by a half swing of a vibrating electron. We may then compare roughly the wave-length of one of the prismatically resolved components of white light with the wave-length of a Röntgen ray impulse by comparing the half-period of the light with the time of stopping the electron. This time can be shown to be inversely proportional to the energy of the electron, *i. e.*, the frequency of the X-ray produced by stopping an electron may be taken as directly proportional to the energy of the cathode-ray particle producing it. If, then, an X-ray ejects an electron with an energy proportional to the energy of the original cathode ray, ultra-violet light should eject an electron with an energy proportional to its frequency. Notice that this result is obtained without the aid of Planck's equation, but rather immediately from the fairly well demonstrated inter-convertibility of X-rays and β-rays and the assumption that light rays are nothing but soft X-rays. But not only is the absorption of energy by an electron from a light wave proportional to ν, its numerical magnitude is approximated at least by multiplying the frequency of the light by Planck's value of h. It is true there is here no accurate agreement as yet; for part of the energy absorbed by the electron is lost in getting out of the metal, and the exact amount of this loss has not been measured with as much accuracy as we hope soon to be able to attain. Nevertheless the agreement is now sufficiently good (within some 70 per cent.)[36] to lend some support to the notion that the amount of energy actually absorbed from the light by the escaping electron is $h\nu$.

A still further test of the hypothesis can be made by computing the frequency of X-rays from the observed velocity of emission of corpuscles ejected by them; *i. e.*, from the potential difference between the terminals of the X-ray bulb which produces them. Thus we have

$$h\nu = \frac{hc}{\lambda} = eV,$$

or if $V = 40{,}000$ volts (this would correspond to fairly hard X-rays such as Laue used),

$$\lambda = \frac{hc}{eV} = \frac{6.55 \times 10^{-27} \times 3 \times 10^{10}}{4.774 \times 10^{-10} \times \frac{40{,}000}{300}} = 3 \times 10^{-9}.$$

Laue[37] gets from his diffraction patterns wave-lengths ranging from 1.27 to 4.83×10^{-9}. Walter and Pohl's previous diffraction measurements[38] also gave a value of the order 10^{-9}. This is certainly striking agreement, and lends some support at least to the attempts to extend Bragg's assumption of the inter-convertibility of X- and β-rays to the inter-convertibility of light rays and β-rays, or more generally, to the assumption that whenever an electron is emitted a quantity of radiant energy $h\nu$ is absorbed.

Furthermore, according to the most recent experimental results it doesn't seem to make any difference in what form this energy approaches the atom which is to take it on and reemit it. Thus Whiddington[39] and Beatty[40] show that characteristic X-rays are excited either by other characteristic X-rays which are harder than

[35] *L. c.*

[36] Hughes, *l. c.*

[37] *Münch. Ber.*, 363, 1912.

[38] Sommerfeld, *Ann. der Phys.*, 38, p. 473, 1912.

[39] *L. c.*

[40] *Proc. Roy. Soc.*, 87, p. 516, 1912.

those to be emitted, or by the direct impact of β-rays of a corresponding energy; and again, there is now good evidence to show that whenever an electron ionizes a gas its energy of impact must exceed $h\nu$ where ν is now the natural period of vibration of the resonator within the atom which is responsible for the selective photo-electric effect.[41] All of these results are certainly successes of Planck's "Wirkungs quantum" h, though in directions scarcely contemplated originally by the theory; for in Planck's theory it is the natural period of the oscillator which determines the emission of energy in units of size $h\nu$, but in the normal photo-electric effect the emitted electron has an energy which has nothing to do with its natural period, if it has one. It is rather the period of the incident waves which determine the energy with which the electron is ejected.

I think I have now stated most of the important experimental facts which we proposed at the outset to review in the light of atomistic theories of radiation. When we look back over these experimental data there are two main results which stand out conspicuously through it all. *The first is that neither atoms nor electrons appear to be able to absorb any energy until it comes to them in a certain degree of intensity, and this degree varies with different substances.* We see this in the realm of low intensity heat waves where, in the measurement of atomic heats, different kinds of atoms seem to take on their normal energy load at different stages, as temperature rises, the lighter atoms taking it on in this case last; we see it in the realm of high intensity heat waves, such as are dealt with in finding black-body radiation curves; we see it in the realm of photochemical or photo-electric radiations, where different substances begin to emit electrons at different frequencies of the incident light; and finally we see it in the realm of X-rays, where different substances are excited to emit characteristic X-radiations at different hardnesses, the heavy atoms in this case responding last, instead of first. We see further that *one intensity factor h proves itself, to say the least, exceedingly useful in every one of these domains.*

The second important fact that stands out is this, that *in all types of experiments in which the absorption of energy results in the emission of electrons there is apparently a complete, or nearly complete, inter-convertibility of energy between an electron and a so-called ether ray, whether it be an X-ray or a light ray.* Now the first of these two facts is the one upon which one group of quantum theorists is focusing its attention and demanding a unitary theory which emphasizes primarily an emission of energy which is discontinuous in time. The second fact, and it is the one which is the more striking and the better established, is that upon which the other group of theorists is focusing its attention and demanding an atomistic theory of radiation as regards space relations. Now the fifth and last of the quantum theories which I have presented is that which, in view of both of these groups of facts, demands a quantum theory which combines both of these characteristics. The facts *which have been here presented* are obviously most completely interpreted in terms of such a theory, however radical it may be. Why not adopt it? *Simply because no one has thus far seen any way of reconciling such a theory with the facts of diffraction and interference so completely in harmony in every particular with the old theory of ether waves.* Lorenz will have nothing to do with any ether-string theory, or spotted wave-front theory, or electro-magnetic corpuscle theory.

[41] Franck u. Hertz, *Ber. d. D. Phys. Ges.*, 13, p. 967, 1911, and 14, p. 167, 1912.

Planck has unqualifiedly declared against it, and Einstein gave it up, I believe, some two years ago; and yet a quantum theory which fails completely to interpret or take any account of the most striking and the best established experimental fact which demands a modification of old theories, viz., the independence of the energy of emission of electron upon the intensity of the source, or, more generally, the inter-convertibility of β-rays and ether rays is, at best, a very impotent affair. If we are going to leave either of these two main groups of facts out of account I think almost any experimentalist would say that the first group (that having to do with the universal constant h) can most easily be spared: for if we could have radiant energy localized in space we might possibly account for all the experimental facts without having it emitted by a given source in exact multiples of something, but spreading ether pulses which contain energy in multiples of something are certainly wholly inadequate. They go but a short way toward accounting for the present experimental situation. In conclusion then we have at present no quantum theory which has thus far been shown to be self-consistent or consistent with even the most important of the facts at hand, and yet it looks as though one had to come, and when it comes I can scarcely believe that it will be one of the milder forms. That we shall ever return to a corpuscular theory of radiation I hold to be quite unthinkable. The facts of the static field alone seem to preclude such a possibility. But I see no a priori reason for denying the possibility of assigning such a structure to the ether as will permit of a localization of radiant energy in space, or of its emission in exact multiples of something, if necessary, without violating the laws of interference. That no one has as yet been able to do this can scarcely be taken as a demonstration that it can not be done. Fifty years ago we knew that such a thing as an atom existed, but we knew absolutely nothing about its structure, and it was customary to assume that it had none. To-day we know a great deal about the structure of the atom, but the position formerly occupied by it has been assumed by that thing which we call the ether. We know that there is a vehicle for the transmission of electromagnetic energy, but we know nothing whatever about its structure and it has been customary to assume that it has none. To deny the existence of this vehicle, which we have been in the habit of calling the ether, and to use the word "vacuum" to denote *all* the properties heretofore assigned to it by the experimentalist, viz., those of transmitting electromagnetic disturbances, is a bit of sophistry in which he is little interested. We seem to be on the eve of learning something more about the properties of this vehicle, call it by what name you will, than we have known heretofore. Certainly there has never been a time when physics offered such tasks to its followers as now, nor ever a time when it needed more and better brains applied to these tasks. It may be that "THOU art come to the Kingdom for such a time as this."

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EDUCATIONAL DIAGNOSIS[1]

UP till a score of years ago theories of intellectual and moral diagnosis suffered from two defects. They had not fully abandoned the notion that mysterious inner forces or agents existed—memory, attention, courage, imitativeness, constructive-

[1] Address of the vice-president and chairman of Section H—Education—American Association for the Advancement of Science, Cleveland, December, 1912.

ness, emulation, kindness, reasoning power and the like—each of which was a faculty or essence whose nature and degree of strength at any one time could be measured once for all. They had not even begun to abandon the notion that men were classifiable mentally into a rather small number of rather distinct types.

The early practise of diagnosis amongst psychologists, so far as there was any, consisted in inferring the condition of the individual's memory, imagination, power of attention, suggestibility and the like, from some facts in his behavior in which these magic powers "expressed" themselves, and in defining him as of this or that "type" on the basis of his divergence from the average in one or the other direction. Workers in schools who had progressed so far as to know of these practises either accepted their validity or distrusted them without knowing why they did so. The great majority of teachers continued to judge intellect, character and skill by the traditional means used and slowly improved by generation after generation since man could think and speak.

The active experimentation with objective "tests" of mental traits during the last score of years has shown that "goodness" of memory in the sense of a uniform power to hold all that is acquired, closeness of concentration in the sense of a uniform power to resist at will distractions of every variety and other similar general excellencies or defects, were myths. The measurements of correlations of the last decade have shown that "types" of attentiveness, of imagery and the like, and of intellect or character as a whole, either do not exist at all or are so complicated by intermediate conditions as to be of no service to thought or practise.

The experimentation with tests and the measurements of correlations began, however, with faith in the dogmas which they eventually disproved. The great majority of workers in the early days of tests assumed that certain formal general powers of mind existed, the strength of each being easily diagnosed by any one of its manifestations. Learning ten digits or nonsense-syllables was a test of "memory." He in whom the words violin, whistle, bell and brook aroused images of sound was thereby classified apart from him in whom they aroused images of sight. "Endurance" was measured by the ergograph, or by addition, or by the rate of tapping. Idiocy, imbecility and feeble-mindedness were three real entities, with symptoms awaiting our discovery. Even to-day much of this expectation that the intellectual and moral condition of an individual can be adequately described in adjectives, and manifests itself by the clear presence or absence of symptoms in the way that measles and smallpox do, remains.

Experimentation began to cure itself of these traditions as soon as it began to test the tests themselves. As fast as it abandoned the habits of assuming *a priori* what a certain fact in behavior signified concerning the individual's constitution, and sought instead to discover by exact—that is, quantitative—observation just what constitutional features it actually did go with, the older easy but false diagnosis was exposed and the basis for present and future achievement was laid.

Such studies of symptoms and tests are roughly of two sorts, those in which two distinct groups are compared in respect to the trait in question and in respect to the various possible symptoms of it, and those in which a long series of groups, each differing but little from the next in order, are so compared. In both cases certain principles of method are very desirable, almost necessary, because of the continuous grada-

tion of men in mental traits up and down from a common mediocre condition and the wide variability of the same person's performance in the same test.

In the case where two groups are compared in respect to some condition (call it T) and in respect to some possible symptoms thereof (call them $S_1, S_2, \cdots, S_n$) it is almost imperative that the amounts of T, S_1, S_2, etc., possessed by *each individual* be at least roughly determined. Unless this is done we can not tell how symptomatic of T each S is, nor compare the significance of these S's with others tested in some other investigations; we can only say of each of them that it is or is not, in some undefined degree, symptomatic of T; and perhaps that it is more or less so than others of the S's tested in the particular investigation. For example, in testing tests for general mental ability, Mr. Terman, who merely chose five very bright boys and five very dull boys without determining how bright or how dull they were, has left all his results undefined in quantity and incomparable with any one else's. An otherwise admirable study has thus had far less influence on educational diagnosis than it should have had. It is also desirable that the differences within either group in respect to T be small relatively to the difference between the central tendencies of the two groups, and that the extent to which each S separates the first from the second group be stated in an exact and commensurate quantity.

Unfortunately, the great majority of studies of sane *versus* insane, ordinary *versus* feeble-minded, bright *versus* dull, color-blind *versus* color-keen, musical *versus* non-musical, and the like, have left one or more of these three requirements unfulfilled.

I can not quote a study that is beyond reproach in all these respects, but the following facts from Dr. Simpson's test of tests of general intellectual ability will illustrate them roughly. Dr. Simpson defines the first of his two groups by the fact that they were all teachers or graduate students in a university. The group compared with them were all "men in New York City who had never held any position demanding a high grade of intelligence," who spoke "English as their mother tongue."

Two of them were persons earning comfortable livings for their families, but men recognized by their associates as being dull. Eleven others were staying at the Salvation Army Industrial Home at the nominal salary of $1.00 per week in addition to board and room, until work could be secured. One of these held a somewhat responsible position at the time, acting as assistant superintendent of the home. He stood high in the most significant tests. The remaining seven were found in a mission on the Bowery where they were being helped somewhat until they could find employment.

As a measure of the extent to which each symptom or test separates the "Poor" from the "Good" groups, the degree of overlapping is taken. For example, the facts for four tests—giving the opposites of words, memorizing lists of words, marking the A's on a sheet of printed capitals, and discriminating lengths—were: The point reached by 50 per cent. of the "Good" group was reached by none of the "Poor" group in the opposite test or in memory of words; by 15 per cent. of them in the A test; and by 33 per cent. in the case of discrimination of length. The point reached by 76½ per cent. of the "Good" group was reached by none of the "Poor" group in the opposite test; by 5 per cent. in the case of memory of words; by 20 per cent. in the case of the A test, and by 62 per cent. in discrimination of length. The percentages of the "Poor" group reaching the points reached by 88 per cent. and by 94 per cent.

of the "Goods" are shown similarly in Table I.

TABLE I

Percentages of the "Poor" Group Reaching Certain Points of the "Good" Group's Ability

Percentages of the "Good" Group Reaching Certain Points on the Scales	Percentages of the "Poor" Group Reaching the Corresponding Points			
	Opposite Test	Memory of Words	A Test	Dis of Length
50 per cent.	0	0	15	33[2]
76½ per cent.	0	5	20	62[2]
88 per cent.	0	10	25	73[2]
94 per cent.	0	10	25	88[2]

It is obvious that the opposite test is highly symptomatic of something which differentiates these two groups; that the tests in discrimination of length are not; and that the four tests are—in order of merit as symptoms—in the order named, giving opposites, memorizing words, marking A's and comparing lengths.

When a series of groups, each differing slightly from the next in order in the amount of the *T* or *S* taken as the basis of comparison, are used, the method of testing a symptom's significance is by its *correlations*—by the closeness of the correspondence of the rankings of the individuals in the *S*'s with their rankings in the *T*. Thus twelve of the "Good" group in the preceding illustration were ranked, each by all[6] the rest (they being somewhat acquainted with the others' abilities), for general intellectual ability. It is then possible, by means which I will not rehearse here, to measure the closeness of correlation or correspondence between the measure for each man that would have been so obtained had this "imputed intelligence" been determined from 12,000, instead of 12, judges of each man, on the one hand, and the measure obtained for him by repeated testing with any of the tests. These correspondences as calculated for the four tests mentioned were: 96 hundredths of perfect correspondence in the case of the opposites test, 93 hundredths in the case of the memory of words, 21 hundredths in the case of the A test, and apparently zero in the case of discrimination of length.

This method allows a very delicate choice amongst tests, provided adequate data are at hand.

Suppose, for example, that arithmetical ability is defined as the ability required by a given selected set of a hundred arithmetical tasks or problems. We can find which ten of these will serve best as a test of the ability measured by the entire hundred, by measuring a suitable group in respect to the entire hundred, and choosing that set of ten whose combined score correlates most closely with the combined score for the hundred (the pairing being by individual pupils). This method not only demands much time in experimentation and calculation, but also a thorough understanding of the general logic and technique of measuring relations, including the peculiar relation of resemblances or mutual implication. For example, suppose that twenty children, who had in a given year been absent, respectively, 100 days, 95 days, 90 days, etc., down to 5 days, attained, respectively, average academic grades of 74, 75, 77, 77¼, 77½, 78, 78¼, 78½, 79, 79¼, 79¾, 80, 80½, 80¾, 81, 81½, 81¾, 82, 83 and 85. The correlation by any of the stock methods comes out as 1.00, and the investigator might fancy that he had proved that for the school in question the mark to be received could be perfectly prophesied from, and was determined by the same causes as, the attendance record. Nothing of the sort, I assure you, is proved by this perfect correlation. It would perhaps puzzle some of us to tell just why.

The method of observing the correspondence of an individual's status in the trait

[2] Average of three series.

[6] Or nearly all.

taken as a symptom with his status in other traits of whose condition it may be a symptom is of course of wider application than shown in the case supposed. An individual's status in anything may be thus compared with his status in anything else and the correspondence measured. Achievement in school studies may be compared with achievement in adult life; how far skill in motor control and craftsmanship is a symptom of ability in abstract intellectual operations may be determined; whether mental ability is or is not indicative of mental health may be decided; what an individual's interests mean for his capacities, or what his ability in any one test means concerning his ability in any other, may be found out.

One special application of the method of correlation is so important as to deserve separate mention. This is its use in testing a symptom by its correlation with some future condition. When a psychological or educational measurement of an individual enables us to make a successful prophecy concerning the individual's future and one that could not otherwise have been made, we have not only the most impressive but also the soundest proof of the significance of the symptom in question. Thus we rightly increase our faith in Mr. Courtis's analytic tests of arithmetical abilities, if we find that he is able to prophesy truly that a certain student's work in algebra will be greatly improved by certain specified drills in the fundamental operations in arithmetic, though the usual observations of her teachers gave no hint of this.

The most important accomplishment of the last decade's study of intellectual and moral diagnosis has been to establish principles of method for testing symptoms. But there has been also a substantial beginning in accumulating facts of symptomatology which education and the other social arts can henceforth use. These I shall not try to summarize, but only to illustrate.

As our first illustration of the knowledge of intellectual diagnosis that has been attained and may be expected soon to be much increased, let us take the case of general intellect—the ability to manage ideas—the average station of a man in respect to that group of powers which we call intellectual.

In order to avoid technicalities and to gain clearness I shall go somewhat beyond the specific results obtained by Burt, Bonser, Norsworthy, Simpson, Spearman, Krueger, Peterson and myself in testing tests of general intellectual ability. I shall in fact be guilty of prophesying what would occur rather than measuring what has actually been found to occur. However, the prophecy follows by straightforward inferences from facts found by one or another of these workers. Moreover, since I shall be careful to underestimate rather than overestimate the closeness of the correlation between an individual's general intellectual ability and his ability in any of the tests, the prophecy will be safe as an argument that the results of the study of mental tests are beginning to be important for education and the other arts of social control of human nature.

Suppose the men and women of this audience were measured in respect to these eight tests, four trials of each being given:

1. Supplying words to make sense in mutilated passages, the four trials being of four grades of difficulty.

2. Giving the opposites of words, each trial comprising twenty words, the four trials being of four grades of difficulty.

3. Memorizing a given word in connection with a given form, as in Fig. 1, so as to give the former when the latter is presented (there being ten pairs in each "trial").

4. Selecting from 50 forms, as in Fig. 2, 25 forms previously shown and examined for a minute or two. The 25 forms are shown in Fig. 3.

Fig. 1

5. Marking the necessarily false statements in mixed series of false and true statements, the four trials being of four grades of difficulty.

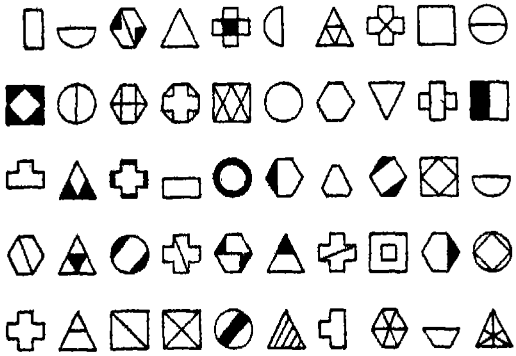


Fig. 2

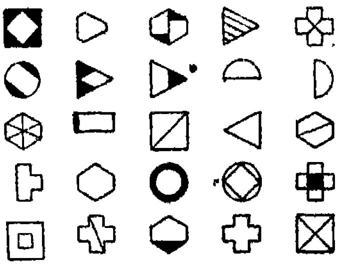


Fig. 3

6. Addition.

7. Doing what is directed in such instruction-sheets as:

Cross out the smallest dot . . .
How many ears has a cat
Make a line across this line |
etc., etc.

and

With your pencil make a dot over any one of these letters: F G H I J and a comma after the longest of these three words: boy mother girl. Then if Christmas comes in March, make a cross right here ...... but if not, pass along to the next question and tell where the sun rises ...... If you believe that Edison discovered America cross out what you just wrote, etc., etc.

8. Selecting valid from invalid reasons for a given fact, the four tests being of four grades of difficulty.

The time required would be approximately two hours, say thirty minutes a day on four days chosen at random.

From the combined score made by an individual in these eight tests, his general intellectual ability—his capacity, that is, for science, scholarship and the management of ideas of all sorts—could be prophesied with a surprisingly small error. Suppose that the general intellectual ability of the dullest men who are able to look after and support themselves (men who though temperate and strong earn say $400 a year in good times in New York City) be represented by a and that of Aristotle or Goethe by $a + b$, the difference, b, being 100. Then the amount of such ability assigned by the test alone would not, on the average, vary from the individual's true amount by more than 5; and would not vary therefrom by more than 14 in one case out of a hundred. The 5 and 14 are very cautious estimates, 4 and 11 being probably nearer what such an experiment would in fact reveal.

If each of us knew all in the company well and wrote down the names in an order of general intellectual ability, and if all of these orders were combined into an order representing the impartial judgment of the

total group about each of its members, this order would be hardly any truer than the order got by using the combined scores of the tests alone. The two orders would indeed be practically identical. There is excellent reason to believe that it is literally true that the result of two hours' tests properly chosen from those already tested gives a better diagnosis of an educated adult's general intellectual ability than the result of the judgments of two teachers or friends who have observed him in the ordinary course of life each for a thousand hours.

There might, of course, be amongst this group certain individuals of great but very highly specialized intellectual ability, as in music or military strategy or mathematics, who would be rated much lower by this team of tests than by the general test of life itself. There might also be certain individuals especially able in just the lines of intellect which these eight tests measure, but low in others, so that their rating by these tests would be much too high. However, such extremely specialized intellects seem to be rare, and this team of tests covers a wider range of the various factors to which men assign credit as intellectual ability than a superficial examination reveals. No student of the matter would pretend to diagnose a man's station amongst other men for total intellect perfectly in two hours, or in twenty! But we can by these tests measure approximately the general intellectual ability of educated men when personal knowledge of them and their achievements is lacking, and can enrich and improve on that knowledge, when it is present.

As a second illustration I choose the very practical case of prophesying how long a pupil will continue in high school.

Dr. Van Denburg secured certain information from each of a thousand pupils entering the public high schools of New York City in February, 1906, and then kept track of the length that each continued in the high school. Consider first the significance of the pupils' answers to the following questions, obtainable in ten minutes or so on the very day that a pupil enters the high school: "What do you intend to do for a living?" "Do you intend to stay in high school four years?"

If we let a line two inches long represent eight terms or four years, and draw below it the lines representing the median length of stay[4] in high school of each of the groups of pupils defined by one sort of answer, we get the facts shown in Fig. 4.

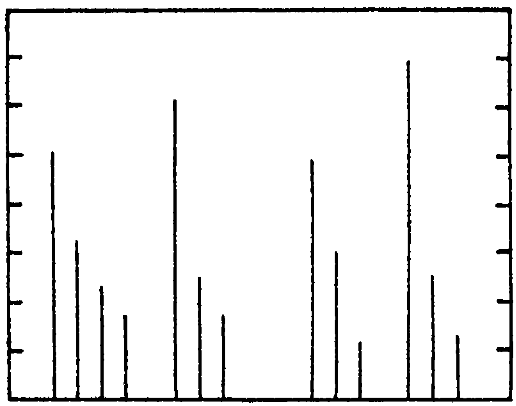


FIG. 4

It is the case, of course, that the prophecy made for any individual is only one of probability. A pupil who reports herself as intending to complete the course may stay only a half year and a pupil who reports himself as intending not to complete the course may remain for four years. Only in the long run and on the average can we be certain that the latter will stay five times as long as the former. The expectation for the two groups is shown more

[4] That is, the length of stay that half of the pupils in the group in question stay longer and half not so long.

completely in Fig. 5, where the area over each successive fraction of the four years represents the percentage of pupils who drop out from high school during that frac-

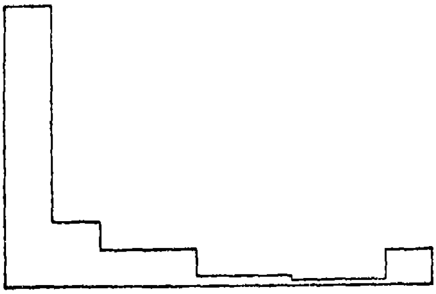


Fig. 5a

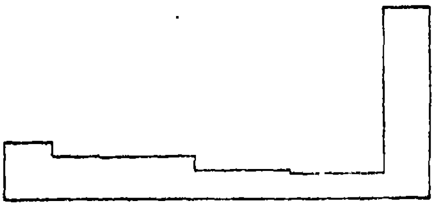


Fig. 5b

tion of the four years. Thus the chance that the "no" pupil will drop out before the second half year is 58 out of 100, or almost five times the chance that a "yes" pupil will. The chance that a "no" pupil will stay four years is 7.3 out of 100 or less than one fifth the chance that a "yes" pupil will.

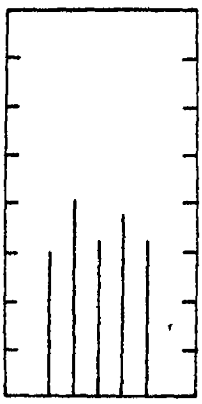


Fig. 6

An important negative fact in diagnosing the probable length of a pupil's stay in the New York City public high schools is shown in Fig. 6. Economic conditions, as measured by the family expense for rental, are seen to be insignificant.

In from one to three months after these pupils entered school they were rated by their teachers for ability, defined as follows: "Native ability apart from success or failure in any particular subject of

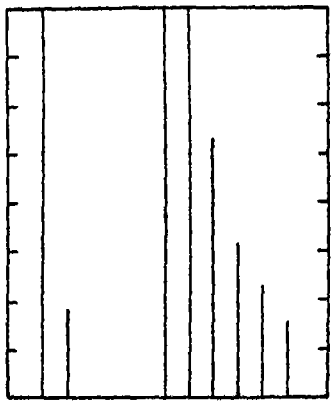


Fig. 7

study. Natural brightness." The median expectation of the top tenth and bottom tenth by the rating are as shown in Fig. 7, the detailed facts being given in Fig. 8.

For those of the pupils who stayed through the first term or nearly to its close so as to receive formal school marks in their studies, the relation of school achievement in the first term to length of stay was calculated. It is shown in part in Fig. 7 and Table II. Ten times as many of those marked below 50 leave in the first year as of those marked 90 or above. Of 115 pupils marked below 50 not one remained to graduate in four years. As the marks rise the percentage leaving in the early years steadily falls, and the percentage graduating, rises.

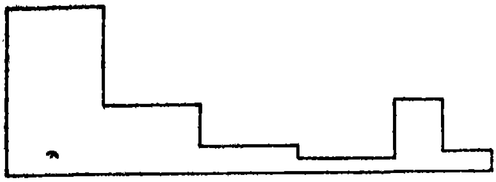


FIG. 8a

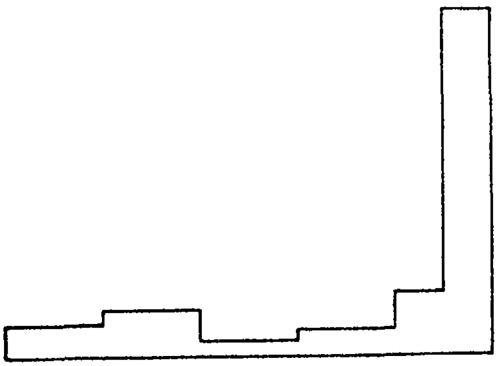


FIG. 8b

TABLE II

The relation of First Term's Mark to Length of Stay in High School

First Term's Average Mark	Percentages Leaving School Each Year After Entrance					
	Left During First Year	Left During Second Year	Left During Third Year	Left During Fourth Year	Remained Four Years Without Graduating	Graduated
Below 50	61	22	8	4	6	0
50 to 59	49					5
60 to 69	39					8
70 to 79	20					18
80 to 89	17					37
90 to 100	6	12	12	6	12	54

Such prophecies as these for New York City could easily be worked out for any community. They show that in the important matter of length of stay in school a pupil's career is far from being a matter of unpredictable fortuity. Useful diagnosis of him and prognosis concerning his high school career can begin before he sets foot in the school, and for that matter, as other facts could be adduced to show, before he is born.

These two specimens of recent work in educational diagnosis give a just notion of what may be expected from the scientific study of human capacities, interests and careers. The worker who will make repeated tests of the general intellectual development or the special school achievement of any hundred human beings for any five years of their lives, utilizing the logic and technique appropriate to mental and social measurements, may be sure of contributing to the advancement of educational science.

The work of observing and measuring the relations between traits of man's constitution, circumstances of his environment and events in his career, both as these happen in nature and as they are modified by ingenious experiment, is sure to increase our knowledge of his nature and our power over his fate. It will not be long before the members of this section will remember with amusement the time when education waited for the expensive test of actual trial to tell how well a boy or girl would succeed with a given trade, with the work of college and professional school, or with the general task of leading a decent, law-abiding, humane life.

This work of testing tests—of measuring the relations of this and that feature of a man's educational life-history—has been neglected by many of the ablest students of human nature and education, partly, I think, because it seems to lack the inspiration of sweeping theories and the drama of immediate consequences. From the ordinary point of view it is a little trivial and tedious. But in the sense that the law of gravitation has a grandeur far beyond that of the heavens—in the sense that a change in the death-rate is the most truly dramatic event in nature—in this sense the task of testing tests gives way to no scientific work in dignity and humaneness. Tables of cor-

relations seem dull, dry, unimpressive things beside the insights of poets and proverb-makers—but only to those who miss their meaning. In the end they will contribute tenfold more to man's mastery of himself. History records no career, war or revolution that can compare in significance with the fact that the correlation between intellect and morality is approximately .3, a fact to which perhaps a fourth of the world's progress is due. Experiments measuring the effects of school subjects and methods seem pedantic and inhuman beside the spontaneous tact and insight of the gifted teacher. But his personal work is confined by time and space to reach only a few; their results join the free common fund of science which increases the more, the more it is used, and lives forever.

E. L. Thorndike

W. G. WRIGHT

William Greenwood Wright died on Sunday afternoon, December 1, 1912, in the eighty-third year of his age. He had been in apparently good health and spirits for some time past. He was found dead sitting in his chair, a newspaper fallen from his relaxed grasp. The cause was heart failure.

He was born near Newark, New Jersey; his early education was limited. He was a soldier in the Union army during the civil war, and soon after the close of that conflict he must have come to California, where he resided a few years in Los Angeles, where his only child was born and died in infancy. He went to San Bernardino about 1873, where he resided until his death and where he conducted a planing mill. About fifteen years ago he retired from active business, and spent his time in collecting and gathering material for his work on butterflies. His wife died a number of years ago, and he leaves no near relatives.

His collection of butterflies and library he has left to the California Academy of Sciences, San Francisco. Some other collections are to be sold. Mr. S. B. Parish, the noted botanist, and the executor of Wright's estate, has given me the few data now obtainable.

W. G. Wright traveled all over the west coast from Alaska to Mazatlan, Mexico, collecting specimens in various departments of natural history, but especially the Lepidoptera. He published an interesting account of his travels in Mexico in *Zoe*. An article in the *Overland Monthly* for 1884 is entitled "A Naturalist in the Desert," and an article on "Collecting in Alaska," which can not now be located. Other papers are found in *Entomologica Americana, Canadian Entomologist, Papilio, Entomological News* and Edwards's "Butterflies of North America." Perhaps the most important service he rendered to science was the help he gave to W. H. Edwards in the great work just mentioned. In the *Ornithologist and Oologist*, for February, 1885, we find an article on "An Experiment in Bird Taming," with *Phainopepla nitens;* his name is frequent in the two large volumes, "Botany of California," as he was an enthusiastic collector of plants. His most important book, "The Butterflies of the West Coast," was published in San Francisco in October, 1905, and was really an epoch-making publication, notwithstanding the numerous inevitable mistakes. This work was illustrated entirely by color-photography.

Among the insects which have been named in his honor by different men, are: *Melitaea wrightii, Copaeodes wrightii, Gluphisia wrightii, Leptarctia wrightii* and *Selidosema wrightiarium*. He named a number of new species, but a good many of these, especially those in his 1905 book, are synonyms.

Mr. Wright was a close friend of the two noted pioneer botanists and collectors, Edward Palmer and C. C. Parry, and made many excursions, of varying lengths, with them. He knew many other botanists and entomologists also.

W. G. Wright will always be remembered by those who were so fortunate as to have known him personally. He was a *naturalist*

in the true sense; such naturalists becoming fewer as the years pass.

The captains and the kings depart.

FORDYCE GRINNELL, JR.

PASADENA, CALIFORNIA

SCIENTIFIC NOTES AND NEWS

SIR HENRY ROSCOE celebrated his eightieth birthday on January 7 at Woodcote Lodge, West Horsley. His former pupils and friends have resolved to commemorate the occasion by presenting his bust to the Chemical Society of London. A deputation headed by Sir Edward Thorpe went to Woodcote and presented an address of congratulation.

THE twenty-fifth anniversary of Professor Charles Richet's appointment to the chair of physiology at the Faculté de médecine de Paris was celebrated on December 22. He was presented with a *Festschrift* containing some eighty contributions from distinguished physiologists, and addresses of congratulation were made.

CAPTAIN ROALD AMUNDSEN received the gold medal of the American Geographical Society on January 14, when he addressed in Carnegie Hall an audience of 3,000 persons. He will receive the gold medal of the Geographical Society of Chicago on February 3. He will be the first to receive this medal, as he was the first to receive the Culver Gold medal in 1907.

PROFESSOR GEORGE C. COMSTOCK, director of Washburn Observatory, University of Wisconsin, has been elected a fellow of the American Academy of Arts and Sciences.

DR. GEORG CANTOR, professor of mathematics at Halle, has been made an honorary doctor of the University of St. Andrews.

MAJOR SIR RONALD ROSS, F.R.S., has been appointed physician for tropical diseases to King's College Hospital, and will take up his duties in the autumn, after the removal of the hospital to Denmark Hill. Sir Ronald Ross is now professor of tropical sanitation in the University of Liverpool.

PROFESSOR FRANZ BOAS, of Columbia University, has been appointed lecturer in anthropology at Harvard University for the second half year.

AT the recent meeting of the American Phytopathological Society at Cleveland the following officers were elected for 1913:

President—F. C. Stewart, New York Agricultural Experiment Station, Geneva, N. Y.

Vice-president—Haven Metcalf, U. S. Department of Agriculture, Washington, D. C.

Secretary-treasurer—C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

Councillor—W. J. Morse, Agricultural Experiment Station, Orono, Me.

The society decided to hold its next annual meeting at Atlanta, Georgia, in conjunction with the American Association for the Advancement of Science.

PROFESSOR A. S. HITCHCOCK, systematic agrostologist, U. S. Department of Agriculture, has returned from the West Indies. He visited Jamaica, Trinidad, Tobago and, incidentally, Cartigena and Puerto de Colombia. In Jamaica 643 numbers of grasses were obtained, representing about 168 species, and including all except four of the species known from this island, and many species not hitherto recorded. From Trinidad 337 numbers were collected, representing 140 species, and from Tobago 90 numbers representing 65 species. Mr. Hitchcock was successful in recollecting nearly all the species whose type localities are in these islands.

PROFESSOR WILLIAM J. G. LAND, of the department of botany of the University of Chicago, has returned with a large collection of botanical specimens from Australia and the islands of the Pacific.

MR. A. C. VEATCH, formerly chairman of the Land Classification Board of the United States Geological Survey, has arrived at the Cosmos Club, Washington, D. C., from London. He expects to spend a short time in the United States looking for men to assist him in his geological investigations, which have extended to many parts of the world.

PROFESSOR J. E. DUERDEN, Rhodes University College, Grahamstown, South Africa, has been invited by the government of British

East Africa to visit the protectorate to lecture and advise upon ostrich farming.

The president of the British Board of Education has appointed an advisory council for the Science Museum, London. The council will be asked to advise the board on questions of principle and policy arising from time to time and to make an annual report on their proceedings to the board, together with any observations on the condition and needs of the museum which they may think fit to make. The following will be the first members of the council: Sir Hugh Bell, Bt., chairman; Mr. R. Elliott Cooper; Dr. J. J. Dobbie, F.R.S.; Mr. W. Duddell, F.R.S.; Mr. E. B. Ellington; Sir Maurice FitzMaurice; Sir Archibald Geikie, F.R.S.; Dr. R. T. Glazebrook, F.R.S.; Sir Alfred Keogh; Sir William Mather; Sir John Murray, F.R.S.; Sir William Ramsay, F.R.S.; Sir Henry E. Roscoe, F.R.S.; and Sir William H. White, F.R.S. The secretary will be Captain H. G. Lyons, F.R.S., of the Science Museum.

Professor Charles S. Minot, who is now serving as the Harvard Austausch-Professor at Berlin, delivered from December 16 to 21 six lectures on "Moderne Probleme der Biologie" before the University of Jena. The subjects were:

1. The new cell doctrine.
2. Cytomorphosis.
3. The doctrine of immortality.
4. The development of death.
5. The determination of sex.
6. The conception of life.

The lectures were delivered before the university in the Aula and were attended by both students and professors. At the third lecture the Grand-duke of Saxe-Weimar was present in his official capacity as rector of the university. It was at his suggestion that the arrangement was made with the Prussian ministry of education by which the Harvard professor was to visit Jena, as an acknowledgment of the visit to America of Professor Eucken, who is a member of the philosophical faculty of Jena. It is the first time that an American exchange professor has served officially at any German university besides that at Berlin. Professor Minot's lectures were delivered in German and will be published shortly by the firm of Gustav Fischer.

Under the auspices of the department of geology of Columbia University, Professor William Morris Davis delivered a series of three lectures from January 14 to 16 on "Dana's contribution to Darwin's theory of coral islands," "The Valley of the Armançon: a study in physiographic analysis," and "The principles of geographical exposition." On January 17 Mr. Donald F. MacDonald, geologist of the Panama Canal, addressed the students of the department on "The general geology of the Panama Canal Zone."

During the week of December second, Dr. S. W. Williston, professor of vertebrate paleontology in the University of Chicago, gave the annual Sigma Xi lectures in a circuit composed of Washington University, University of Missouri and the University of Kansas. His subjects were "The Earliest Land Animals" and "The Evolution and Distribution of the Earliest Land Animals."

Dr. George C. Comstock, of the University of Wisconsin, gave the Sigma Xi address at Purdue University on January 17, his subject being "The Study of the Stars."

Dr. J. A. Detlefsen, of the Agricultural College of the University of Illinois, has delivered a series of lectures before the Kansas Agricultural Board and University on "Genetics in the Agricultural College."

Professor H. J. Wheeler, manager of the agricultural service bureau of the American Agricultural Chemical Company, Boston, Mass., lectured on the eighth inst. before the New Jersey State Board of Agriculture on "Some Interrelations of Plants, Soils and Fertilizers."

Mr. S. A. Courtis, head of the department of science and mathematics in the Home and Day School of Detroit, and supervisor of testing work in the Boston public schools, spoke on January 17, under the auspices of the Harvard chapter of Phi Delta Kappa, an honor society in the division of education. Mr.

Courtis has tested the mathematical ability of several thousand school children in New York and Boston, and described the results of his tests.

Dr. R. Ruggles Gates, lecturer in biology, St. Thomas Hospital, London, is giving a course of lectures on heredity and mutations at the Imperial College of Science and Technology.

The fourth centenary of the birth of Andreas Vesalius, the pioneer of modern anatomy, will be celebrated this year with appropriate ceremonies at Brussels.

Thaddeus S. C. Lowe, of Los Angeles, chief of the aeronautic corps of the U. S. Army during the civil war, died on January 16, in his eighty-first year. Mr. Lowe made inventions in various fields, including balloons and instruments for atmospheric investigation, and artificial ice, metallurgical and water-gas apparatus. He built the Mount Lowe railway and established the Mt. Lowe Observatory in the Sierra Madre Mountains.

Professor George Augustus Koenig, professor of chemistry at the Michigan College of Mines since 1892, and previously professor of mineralogy and metallurgy in the University of Pennsylvania, died on January 14, aged sixty-eight years.

M. Louis Paul Cailletet, the distinguished French chemist, known especially for his work on iron and acetylene and on liquefaction of gases, has died in his eighty-first year.

The death is also announced of M. Léon Teisserenc de Bort, the French meteorologist, known especially for his work with captive balloons.

Dr. Otto Schoetensack, professor of anthropology at the University of Heidelberg, died on December 23 in his sixty-third year.

Dr. Yujiro Motora, professor of psychology in the University of Tokyo, died on December 12. Dr. Motora took the doctor's degree in psychology about twenty-five years ago at Johns Hopkins University.

Frederik Hjalmar Johansen, who accompanied Dr. Nansen in sledge journey across the North Polar ice, and Captain Amundsen on his recent Antarctic expedition, has died at the age of forty-six years.

We regret also to announce the death of Dr. E. Tavel, professor of surgery at Bern, and Dr. G. Tilling, professor of surgery at St. Petersburg.

UNIVERSITY AND EDUCATIONAL NEWS

The Rev. John Henry Ellis, of Collingham-gardens, South Kensington, has left, subject to his wife's life interest, the residue of his property, which will amount to not less than £90,000, to Cambridge University, "to be enjoyed and applied both as to capital and income by them for the general purposes of the university, in such manner as they may think fit."

An anonymous graduate has given Harvard University $80,000 for a building for the department of music, and other graduates and friends have subscribed as an endowment fund for its maintenance more than $50,000. It will be used for the courses in the theory and history of music, the only branches of that subject which are taught at Harvard. It will have a hall of suitable size for chamber concerts, in which will probably be installed a pipe organ. The building will also be the headquarters for the musical organizations of the university.

Yankton College has received from Mr. James J. Hill an offer of $50,000 for increasing the endowment, conditioned on the raising of $200,000 in addition, within two years.

Bates College dedicated on January 14 its new science building, Carnegie Hall. President George C. Chase gave a brief historical address, outlining the growth of the scientific departments at Bates in recent years, and telling of the efforts necessary to raise the $100,000 in order to claim Mr. Carnegie's gift of $50,000. Professor William T. Sedgwick, of the Massachusetts Institute of Technology, gave the formal address, taking as his theme, "The Interpretation of Nature."

At the winter meeting of the board of trustees, Cornell University, held in New York on January 18, the election of a dean of the faculty of arts and sciences was referred to

the faculty with power. This is in accordance with the recommendation made by President Schurman in his last annual report. Hitherto the deans have been nominated by the president and appointed by the trustees.

AT Harvard University Dr. L. J. Rhea has been appointed assistant professor of pathology, and Dr. Dunham Jackson instructor in mathematics.

DR. ALEXIS HARDING, of Geneva, N. Y., has been appointed to the department of dairy husbandry in the Agricultural College of the University of Illinois with the title of professor of dairy bacteriology in the college and chief in dairy bacteriology in the station.

DR. KARL M. WIEGAND has been appointed professor of botany in the State College of Agriculture of Cornell University.

DISCUSSION AND CORRESPONDENCE

UNDERGRADUATE RESEARCH WORK IN MEDICAL SCHOOLS

TO THE EDITOR OF SCIENCE: A recent article in SCIENCE (November 29, 1912) by Mr. Drinker comments upon "Undergraduate Research Work in Medical Schools." In this article I find certain points that deserve comment. One of these points is this:

> If we classify all these schools upon the basis selected by Mr. Flexner in the first report of the Carnegie Foundation in Medical Education, namely, upon the possession or lack of a two years' college entrance requirement, we find that of the schools permitting undergraduate research five fail the test.

The University of Cincinnati is one of the five. Another point is contained in the clause, "Schools permitting research and giving no visible time for it," etc.

I desire to point out that unless qualifications are added to such statements they are very misleading; and also I desire to point out that making the point of a one-year or a two-year requirement means absolutely nothing unless the facts concerning the enforcement of such a requirement are known, and unless the requirement itself is a definite one. I make this statement upon the basis of certain facts that I have collected in the past year.

The University of Cincinnati demands for entrance to its college of medicine one year of specified work in subjects which are generally conceded to be advisable, if not necessary, premedical subjects; namely, physics, chemistry, biology and modern language. At the University of Cincinnati, a year in these subjects means a certain amount of ground covered, in a certain amount of time, *i. e.*, three lecture periods (hour periods), and two three-hour laboratory periods, per week. The admission committee of the college of medicine, composed of the heads of the departments of chemistry, anatomy and pathology, have insisted that students coming from other colleges should present a *working* knowledge in physics, chemistry and biology equal to that demanded of University of Cincinnati premedical students. In the past year or so a few students have been refused admission by our admission committee, in spite of the fact that they had had a college year of physics, chemistry and biology, but had had courses in these subjects which could not reasonably be expected to produce the results that we demanded, or which did not produce these results, as proved by practical, oral, tests. Such students, however, had no difficulty in entering colleges whose announcements place them in the first group of Mr. Flexner. Apparently it is sometimes true that a one-year standard is a higher one than a two-year standard. It makes a great deal of difference whether a school lives up to a standard of efficiency, or a standard of prose (or poetic terms).

With regard to the "visible time" for research, I have no fault to find with Mr. Drinker, because in spite of everything he reaches a conclusion that appeals to me, but "visible time" in a schedule means nothing. If there is no "visible time" it may mean that the schedule has been arranged to suit the students who have just met the requirements, and that, so to speak, "invisible" time is a plenty for those who have more than met such requirements. But even aside—even admitting that all the students just meet the requirement—one needn't treat them all alike. As a matter of fact, it were well to try to treat

all differently. It is interest and enthusiasm we are after in medicine—not the dead routine of a schedule. We need very badly pedagogic vitality. One man may make, or be able to make, twice the progress of another in a certain subject. Why tie him to the class schedule? Why not take him into your own laboratory, for his class periods, give him an assignment of special work, and talk it all over with him. It is a stimulus to students and teachers. It makes for progress in the student, not for stagnation. It widens his perspective, and not infrequently wakes the teacher. A schedule is made for the general mediocrity, and in its planning visibility is a prime necessity.

PAUL G. WOOLLEY,
Dean

COLLEGE OF MEDICINE,
UNIVERSITY OF CINCINNATI

A PROPOSAL FOR THE CONTROL OF CERTAIN MOSQUITOES

WITH the discovery that a number of diseases are transmitted solely by certain mosquitoes the control of these insects has become an important problem. But for successful control work exact knowledge of the species involved and of their habits is essential. Until a decade ago Réaumur's admirable presentation of the life history of the common house mosquito (*Culex pipiens* L.) has been almost universally considered applicable to mosquitoes in general. Nothing was known of the specialization of habits in the different species and it was generally supposed that in temperate regions all mosquitoes hibernated in the adult female condition, to deposit eggs and start a new generation with the return of warm weather. Students of the group now know that there is great diversification of habits and that the old generalizations apply to but a very small proportion of the many species of mosquitoes. Nevertheless, the old ideas persist with many and are still disseminated in well-meant attempts to popularize the subject. One often encounters recommendations for mosquito-control based upon these old ideas and leading to failure and useless expenditure.

The greatest misconception is that swamps and bodies of stagnant water in general continue to produce mosquitoes in quantities throughout the warm months and that to reduce mosquitoes it is only necessary to oil or petrolize such places at sufficiently frequent intervals. In fact the bulk of the mosquito population of our northern woods and swamps (and this is true of Eurasia as well as of North America) is derived from larvæ which develop in the snow-water of early spring. During a short period all the lesser bodies of water swarm with mosquito-larvæ, to shortly become, for the remainder of the season, practically barren. The larvæ hatch from eggs which were deposited the previous summer on leaves or rubbish in depressions of the ground. There is but a single brood and the larval period is short; the female imagos are long-lived (weeks and even months) and the egg-stage lasts through the winter to the following spring.

The species of mosquito which conform to the old idea, hibernating as female imagos and producing a series of generations during warm weather, are, in temperate regions, few in number, and their control is comparatively a simple matter. It is true that in villages, towns and cities even in the northern states these Culex mosquitoes will breed in tin cans and bottles on waste lots, in cesspools, rainwater tanks, rainwater barrels and other receptacles, and cause much annoyance. A community wishing to rid itself of such mosquitoes must carry on a warfare directed against these particular mosquitoes.

The species hibernating as eggs and developing in early spring (mostly belonging to the genus *Aëdes*, sense of Dyar and Knab) are, on the contrary, numerous in species and individuals, and under suitable conditions very annoying. Their control, through destruction of the larvæ, is a difficult matter. Petrolization, the method most recommended, must be carried out at just the right time. As the larvæ occur in practically all the numerous pools of snow-water scattered through woods and fields, operations will have to be very extensive to bring appreciable results. More-

over, in exposed places the wind is sure to drive the film of oil to one side and make it more or less ineffectual. It therefore appears that oiling for the control of these mosquitoes is not practical. Drainage, in many cases, can not be considered on account of the numerous small pools in which the larvæ occur.

The difficulty apparently has been solved in a recent suggestion by Dr. Adolf Eysell.[1] Discussing a recent pamphlet on mosquitoes by P. Sack, he criticizes the antiquated views and states that in Germany only three species of mosquitoes, *Culex pipiens*, *Culiseta annulatus* and *Anopheles maculipennis*, hibernate as imagos and that these are distinctly house-mosquitoes. All the other species, including two of Anopheles, are "wild" and hibernate in the egg or larva state. For the control of those hibernating as eggs Eysell suggests an easy method which should prove effective. It is the removal and burning, late in the autumn, of the old dead leaves and plant débris from the dried-out pools in which the larvæ would later appear. He further suggests that when it is inadvisable or impracticable to burn the egg-bearing leaves they be stacked on higher ground in such a way that they can not be carried back into the depressions by wind or rain. The latter method appears less effectual to the writer on account of the difficulty, at least in many localities, of finding permanently dry spots for such plant-rubbish. When one considers the very small amount of water that is necessary for the development of mosquitoes (the writer has found larvæ and pupæ in puddles less than an inch deep on practically level ground) and the possibility of heavy rains hatching the eggs and carrying away the young larvæ, this method seems less promising. The burning of the accumulations of leaves and rubbish from depressions of the ground, however, should give the best results. It is to be hoped that some one in a locality with well-determined mosquito conditions will give this method a fair trial.

FREDERICK KNAB

BUREAU OF ENTOMOLOGY

[1] *Entomol. Mitteilungen*, Vol. I., No. 11, November, 1912, p. 366.

SCIENTIFIC BOOKS

Comparative Anatomy of Vertebrates. By J. S. KINGSLEY, Professor of Biology in Tufts College. Philadelphia, P. Blakiston's Son & Co. 1912. Pp. 401.

The author's purpose in writing this text-book, as stated in the preface, is to present a volume of moderate size which may serve as a framework around which the facts learned by the student in laboratory work in vertebrate anatomy may be grouped so that their bearings may be readily recognized and a broad conception of vertebrate structure may be obtained. "In order that this may be realized embryology is made the basis, the various structures being traced from the undifferentiated egg into the adult condition." "There has been *no attempt to describe* the structure of any species in detail, but rather to outline the general morphology of *all* vertebrates."

The task of preparing a text-book of this kind limited to a volume of moderate size is extremely difficult. Morphology, unlike physiology, or unlike chemistry or physics, lends itself to relatively few broad generalizations that may be stated without reserve. It deals essentially with data concerning the structure of a vast number of individuals in the adult condition and their development. While organisms are more or less readily classed into various broad and narrow groups according to the details of their structure and the genetic relationship of organisms, on the whole, may be most readily deduced from structural resemblances, nevertheless it remains true that living things are essentially individualistic in the character of their organic structure. Generalizations concerned with the structure of the tissues are much broader than those concerned with gross organic structure. The relatively simple conditions characteristic of the early stages in embryonic development also lend themselves to comparatively broad generalizations. The author, therefore, does well to devote rather more attention to the histological and embryological aspects of the subject than is customary in text-books of this character.

The introduction deals principally with the broader aspects of vertebrate embryology and histology. There then follow accounts of the integument, the skeleton, the cœlom, the muscular system, the nervous system, the sense organs, the digestive organs, the respiratory organs, the organs of circulation, the urogenital system, the fetal envelopes and the adrenal organs. A bibliography of the more accessible books and monographs dealing with the subjects treated, and a list of definitions of systematic names used in the text precede the index. The figures used to illustrate the text are, in large part, original.

It would probably be impossible for an author in a text-book of this size to condense biological generalizations in a manner wholly satisfactory at all times to other students of the subject. Thus, for instance, in describing the neuron Kingsley states that "the processes are physiologically divisible into afferent and efferent tracts, the body of the cell being the place for the regulation and correlation of the impulses and, apparently, in many cells for the inauguration of new impulses." Most neurologists would be inclined to consider the primary function of the cell body to be the regulation of the nutrition of the neuron. Kingsley does not seem to discriminate in the text between "dendrites" and "telodendrons." It is quite certain that the corium is not derived wholly from the somatic wall of the myotomes, as is implied in Kingsley's description of the development of the integument. In describing the articulations of the endoskeleton Kingsley states that "the bones may be so articulated that one can move on the other (diarthrosis), or there may be no motion possible (synarthrosis), each with several varieties." These brief descriptions of the two main types of joints are certainly not happily chosen. In describing entochondrostosis the author states that the cartilage becomes broken down in the interior, some of the cells becoming modified into osteoblasts. This is not the generally accepted view of the process at present. The notochord is certainly not of entodermal origin throughout the vertebrates. In describing the vertebræ the author would have done well to state what becomes of the costal elements of the lumbar and sacral vertebræ. While the use of the term "anterior" to mean the head-end of the animal and the term "posterior" to mean the tail-end of the animal is satisfactory for all vertebrates, including man, it is a mistake to translate "anterior" into "front," and "posterior" into "behind," as may be seen from the following description: "In man it (the sternum) consists of three parts, a manubrium in front, a middle piece, and a xiphoid (ensiform) process behind." The description of the origin of the muscles of the diaphragm in mammals is incorrect and nothing is stated about the interesting nature of the innervation of the diaphragm. The sternocleidomastoid muscle should not be placed in the same group with the scalene and intercostal muscles. The author's division of the muscles of the limb into intrinsic and extrinsic does not seem to aid in giving a clear picture of the morphology of the limb musculature. The Vidian nerve does not represent a distinct sympathetic trunk. The width between the bases of the pillar cells in the organ of Corti increases from the base to the apex of the cochlea instead of decreasing, as described by the author. It is incorrect to describe the duodenum as that part of the alimentary canal which extends from the pyloris to the entrance of the bile duct. The text description of the embryonic origin of the thyroid is unsatisfactory, and the parathyroid glands are not mentioned. The epiglottis does not fold back toward the glottis during deglutition. Hemoglobin does not combine with carbon dioxide. The origin of most of the larger blood vessels in the body from embryonic vascular plexuses, which forms so striking a feature of the development of the circulatory system, is not clearly described by the author, but, on the other hand, the doubtful theory of the development of blood vessels as remnants of the segmentation cavity has a couple of paragraphs devoted to it.

The proof-reading appears at times to have been somewhat careless. Fig. 22 is upside

down. The lettering on the coracoid process, Fig. 108, is incorrect. The olecranon process is described on page 120 as extended beyond the elbow joint to the attachment of the extensor muscles of the lower limb. The lettering of the pancreatic duct in Fig. 242 does not correspond with that of the legend.

Kingsley's book lends itself for comparison most readily with Wiedersheim's "Comparative Anatomy of Vertebrates," especially with the English edition edited by W. N. Parker. The general field covered is similar, although there are about one hundred more pages in Wiedersheim. Wiedersheim has the advantage of having been extensively used and revised since the first edition in 1882, so that the weaker parts have been gradually strengthened and the cruder errors eliminated. On the other hand, a text-book revised from year to year over so long a period may display many points of view less satisfactorily than a text-book newly written. The relatively greater attention given by Kingsley to histology and embryology is a distinct advantage and might be satisfactorily carried out further. On the other hand, both illustrations and text descriptions are, in many phases, clearer in Wiedersheim's than in Kingsley's text-book. The bibliography given in Wiedersheim is far more extensive, but, on the other hand, that given in Kingsley is, on the whole, well selected, and, possibly, for beginning students, by being less extensive may be more useful.

C. R. Bardeen

The University of Wisconsin

The Growth of Groups in the Animal Kingdom. By R. E. Lloyd, M.B., D.Sc. London, Longmans, Green and Co. 1912. Pp. 185, with two colored plates. Price $1.75 net.

"The aim of this small book is to lessen the belief in natural selection as a creative agency." "The word group appears in the title of this work and will be found throughout the text. It is used in place of the more usual terms species, sub-species and variety." "A group is a number of individuals (more than one), each possessing some particular character or characters which are chosen arbitrarily as the distinguishing marks of that group." "From a practical point of view species are those groups which have been described as such."

Although the idea expressed in the last quoted sentence is by no means novel, it is interesting as illustrative of a change which seems to be coming over biology. Many will still dispute both the author's and the reviewer's statements. However, it is indisputable that not only is the "method of the origin of species an open question," but it is more than ever a question as to what a species is if it be more than a mere convention. It is curious that so many well-informed taxonomists accept evolution as a principle, but stick to the independent creation of species in practise. The "splitters" are unconsciously breaking down this practise, for species are being based on fewer and less important characters than ever. The process is a *reductio ad absurdum* and can not help but end in the definition of species just given. The author seems justified in saying: "If it is true that our conception of a species has changed it is necessary to modify our opinion as to the origin of a species. Some of those who are interested in the origin of species do not know how small are the differential gaps which separate our modern species."

About half of the book is devoted to an account of the different sorts of rats found among about 100,000 killed during the work against the plague in India. Some of these have already received names differentiating them from *Mus rattus*. Other have not. As a contribution to our knowledge of the amount of readily appreciable variation in a feral "group," this work is valuable. It is the only important original thing the book contains and is followed by a lengthy résumé of some of Tower's work upon *Leptinotarsa*. Unfortunately the author did not subject the rat "mutants" to experimental tests, nor does he refer to the breeding work already done with rats. The facts collected are believed to be in harmony with that part of the mutation theory which asserts that the attributes of

organisms consist of distinct, separate and independent units.

As a practical application of the theory he suggests that many forms of insanity are merely the distinguishing characteristics of human mutants. "*Dementia præcox* is neither fatal in itself, nor curable, Were it either we could not of course regard it as the expression of a character or group of characters, or compare its victims to mutants." In addition to the punctuation, one might be inclined to object to the implication that the possessor of a new character can not be compared to a mutant if the new character be fatal to its possessor.

The author assures us that the philosophical conclusions in the last chapter were reached before reading Bergson. There is something of a similarity—at least as to the quality of indefiniteness and the appeal to the unknowable. The concluding sentence is a warning that the belief in natural selection encourages a belief in "the right of the spirit of competition which is daily invoked in order to smother those altruistic feelings that are an important part of the human mind."

The discussion of "species" is interesting and the important facts concerning the rats are well presented.

FRANK E. LUTZ

The Flowing Road; Adventuring on the Great Rivers of South America. By CASPAR WHITNEY. Philadelphia and London, J. B. Lippincott Company. 1912. Pp. 319. Illustrated.

The title of this book leads one to look for something in the way of scientific results, but the author disclaims any scientific mission (173), and it is only by much courtesy that it can be regarded as scientific in any sense. But in spite of this, it is a book full of interest for every one who knows, or wishes to know, about the ups and downs of canoe travel in the thinly populated and little-known regions of the upper Rio Negro, or for the matter of that, on any of the rivers that empty into the Amazon.

The author's preface would lead one to suppose that Humboldt and Wallace were almost the only explorers of the upper Rio Negro region, and he fails to mention Dr. Richard Spruce, who lived and labored there longer than all the others put together. Humboldt was on the upper Oronoco only two months—April and May, 1800; Wallace went up the Rio Negro in August, 1850, and returned to Manaus May 17, 1852; Spruce lived in that region from December, 1851, to December, 1854—just three years. The account of Spruce's residence is given in the "Notes of a Botanist on the Amazon and Andes by Richard Spruce, London, 1908," and his results are published in more than fifty scientific papers, mostly on South American botany and natural history, brought out by the learned societies of England and Scotland.

Likewise no mention is made of the almost incredible explorations of Henri A. Coudreau in the Amazon region, including a trip up the Uaupés in 1884, and described in his "Voyage a travers les Guyanes et l'Amazonie," Paris, 1887.

This, however, has but little to do with the book itself. In spite of the almost deadly sameness of the region and of the daily life, the author finds something or much of interest and beauty everywhere, and under all circumstances. And it is a great pleasure to follow a man who likes to see the animals without wanting to shoot them all to pieces, who accepts the weather and the fortunes of travel as they come along without complaint, who has human sympathy with the people, however humble, and who doesn't want to impose his ways of doing things upon every one he meets. This wholesome attitude of the author, even if there were nothing else in it, makes the book richly worthy of the attention of naturalists and of others who would travel in the country treated of.

Another peculiarity of the book is that the author doesn't begin in New York or London with the details of how many trunks, boxes and packages he had and what each one contained; he doesn't describe the voyage out, and the steamer, and the service, and the flying fish, and the southern cross and all the

rest of it. With a brief sketch of the lower Amazon and lower Rio Negro, he begins his story of the trip at Santa Isabel nearly half way up the Rio Negro. With the same promptness, the best of the book—the part which treats of the trip across from Santa Isabel to Ciudad Bolívar on the lower Oronoco—comes to a living end at 4:30 A.M., after his long voyage, when "my canoe grated the sloping bank of Ciudad Bolívar, and I stood upon the beach, bare-legged to the thighs, looking, no doubt, in tattered shirt, like a derelict cast up by the sea."

The remainder of the book is only remotely related to this first and most important part of it, but it is all interesting. Chapter XIX., however, at the end, relates to outfitting for travel in tropical regions and is the best thing of the sort we have seen; and in the opinion of the reviewer the best things among the many valuable suggestions are these: go light, eat what the natives eat, sleep in a hammock, avoid liquor, don't scratch insect bites. He forgot to add: "Learn the language of the people."

This last point suggests that the book contains a few errors in Portuguese which a little care might have avoided. Such are "bateláo" for batelão, "Rio Janeiro" (74, etc.) instead of Rio de Janeiro, "cachaca," rum, for cachaça (43, etc.), "igarapee" for igarapé (47–49), "madrugar" for madrugada (84).

There are also a few erroneous statements in regard to plants which it is hoped may be corrected in future editions: that *farinha de mandioca* is made from the root of a yucca (33); that *piassava* is a "fiber parasite" of a palm (118); that Panama hats are made of "the fine and enduring straw" of a palm. As a matter of fact the piassava fiber is from the edges of the petioles of the palm, and is in no sense a parasite, while the straw of which the hats are made are from the leaves of a species of screwpine.

On the other hand he does well to correct the impression, so popular in temperate regions, that South America swarms with snakes; and he justly discredits the exaggerated stories to be heard all over South America of the numbers and dangers of the jaguars. He does well also to mention the everlasting stumbling blocks placed in the road of the foreign wayfarer (213)—an item the foreigner should be prepared for before he begins his wayfaring.

In his preface Mr. Whitney speaks rather lightly of the fevers and intimates that they belong to the category of robbers and reptiles (4). Having come safely out of some of the most unhealthful parts of South America, it is natural enough for him to think lightly of the fevers. But when he takes a serious view of the possibilities of the region about San Fernando he finds himself confronted by "the insect host and the fever—a forbidding pair" (111).

The writer is in entire sympathy with this author's general cheerful attitude in regard to the people and their ways and the country in general, but he thinks it due to those who are likely to go there to call attention to the abundant evidences of fevers and of their sad work as set forth in "Recollections of an Ill-fated Expedition," etc., by N. B. Craig, Philadelphia, 1907, and indeed in the experience of every one who has lived long in that country.

It is a pity that the book is not supplied with better maps. J. C. Branner

MINERALOGY IN JAPAN

The valuable Japanese periodical issued in Tokyo by T. Wada, under the German title "Beiträge zur Mineralogie von Japan," offers many interesting articles in its fourth number (June, 1912), all of them being written in English by their Japanese authors. Among them we note an account of the fall of meteorites which took place July 24, 1909, in the districts of Mugi and Yamagata, province of Mino.[1] The writer, Tetsugoro Wakimizu, states he was at the time in the town of Ogaki, about twenty miles distant, when he heard a sound like the report of a cannon, accom-

[1] "Beiträge zur Mineralogie von Japan," ed. by T. Wada, No. 4, pp. 145–150, 1 pl., 1 map; Tokyo, June, 1912.

panied by quite noticeable vibration; indeed, the noise was heard over an area of nearly 4,400 square miles. The ground on which this, the most remarkable fall of meteorites noted in Japan, took place, was of elliptical outline, measuring about 7½ miles in length and 3 miles in width. The writer carefully examined 24 of the 25 stones gathered from this field, and he estimates that probably five times as many are still lying in the fields and between the hills. He notes that fewer but larger stones came from the northern part of the territory than from the southern part; the largest weighs a trifle over 89 pounds (1,076.8 *momme* = 40,389.7 grams). All these stones, probably fragments of a single original mass, are a white chondrite with some minute grains of nickel iron and iron sulphide in the interstices between the stone components. Oxidization was very rapid. These meteorites are holocrystalline, consisting of prismatic crystals and grains of olivine and bronzite. The primary crust, from ⅛ to ½ mm. in thickness, is formed of oxidized grains of nickel iron and iron sulphide.

The following gives the results of an analysis of one of these meteorites (Hachiman) by Sugiura in the Imperial Geological Survey of Japan:

H_2O	0.334
SiO_2	41.012
P_2O_5	0.458
TiO_2	0.416
F_2O_3	5.470
Fe	20.583
Ni	0.183
Mn	0.910
CaO	2.768
MgO	24.707
S	2.185
SO_3	0.201
C	trace
Total	99.227

The meteoric iron "Okano" is also described by Tadasu Hiki, and figured on two plates.[2]

The most important article in the number is an account of the mineral resources of the Island of Formosa, ceded to Japan after the war with China in 1895.[3] Gold is present there in fair quantity, the principal mines being near Kiirun. The Chinese carried on gold mining in Formosa as early as 1669, and gold sand was noted on the east coast by the Portuguese in the fourteenth century. The gold deposits near Kiirun were discovered in 1890 by a Chinese who came across gold sand while work was in progress on a bridge over the Kiirun River. The value of the gold obtained in Formosa by the Japanese in 1910 is stated to be 2,119,981 yen or over a million dollars; of this 63,964 yen represented the worth of the placer gold.

Gem minerals are represented to a somewhat limited extent. Chalcedony, white and red-banded, has been found in volcanic rocks at Kappansha and in the Tartō district, and in basaltic cavities in the Hōko-tō group; red, yellow, brown, blue, green and other colors are represented; some specimens here are large enough to be polished for ornamental use. Associated with these latter chalcedonies, attractive semi-transparent opals have been found, sometimes blue and occasionally gray. Minute crystals of zircon occur in the gold placers of the Kiirun River. Red garnet appears in fragments with gold sand and magnetite on the coast of Dainan-ō, and minute garnet crystals occur embedded in crystalline schist at Basshi-sho.

Other articles in this number are: "On the twelve dimples of the aragonite balls, found in Taira, Shinano," by Nobuyo Fukichi, pp. 133–138; "On a Small Sinter-cone Formed by a Geyser at Obama, Hizen," by Denzō Sato, pp. 139–141, pl.; "*Kurokō*, or the Black Ore," by Takeshi Hirabayashi, pp. 151–156. Many interesting data are also grouped under the general heading, "Kleinere Mitteilungen."

A concession for pearl-fishing in the South Ussuri district of western Siberia was recently accorded by the Russian government to A. D. Popoff, of Vladivostok. This field is now being exploited with some success with the aid

[2] *Loc. cit.*, pp. 142–144; plates VII. and VIII.

[3] Yōhachirō Okamoto, "Minerals of Taiwan (Formosa)," *loc. cit.*, pp. 157–188.

of trained divers from European Russia, and the prospects for a satisfactory yield of pearls are considered to be good.[4]

GEO. F. KUNZ

SPECIAL ARTICLES

THE DOCOPHORI OF THE OWLS

EXACTLY a dozen species of *Docophorus* (genus of Mallophagan parasites) have been described from the owls (*Strigidæ*). I think the number is about double what it ought to be. The species center about three well-known and well-differentiated types, represented by the long-established species, *D. rostratus* Nitzsch, *D. cursor* Nitzsch and *D. ceblebrachys* Nitzsch. The name of Nitzsch means that these three species were described about a hundred years ago and were based on specimens derived from European birds. All of these species have since been taken from North American owls, as well as from owl hosts from other parts of the world.

The three species differ markedly from each other in various characters, the most quickly recognizable of which are the shape and markings of the head. In *rostratus* the clypeal portion of the head is drawn out and narrow in front, in *cursor* it is shorter and broader, and in *ceblebrachys* it is still shorter and broader, so that the head is a sort of broad, solid, bull's head. The species might well have been named *taurocephalus*, a name used later by me for another *Docophorus*.

Of the nine other so-called species of owl *Docophori* three have been described from American specimens, viz., *D. syrnii* by Packard from *Strix varia varia* from Ohio; *D. bubonis* by Osborn from *Bubo virginianus* from Pennsylvania, and *D. speotyti*, also by Osborn, from *Speotyto cunicularia hypogæa* from Nebraska and Colorado. *D. syrnii* Packard is unrecognizable. It does not count. Professor Osborn's two species do count, of course. They belong to the *cursor* type of owl *Docophori* and are very partial, indeed, to this type, for they imitate their European model pretty closely. However, Professor Osborn's specimens are different from Nitzsch's. But that is a conspicuous thing about the Mallophaga. The individuals of the same species, when they are taken from different host individuals, reveal easily perceived differences. It is a condition that comes about, probably, through the unusual isolation of the separate groups of individuals that compose the species. Each group, which is at bottom a family group, and represents a family strain, is more or less effectively marooned on an animated island, which is the body of its individual bird host. And hence the variations of each family strain are preserved and accented by the necessary inbreeding due to this isolation.

Thus while Professor Osborn's *cursor*-like species are different, they are not *very* different, and the same is true of several other species of owl *Docophori* representing not only the *cursor* type but the *ceblebrachys* and the *rostratus* type.

I have just received from Professor Cockerell several specimens of *Docophorus* from *Asio flammea* (collected at Boulder, Colorado) and in attempting to determine them I am interested to discover that if I follow tradition I shall have to add another species of *Docophorus* to the list for the owls, which would make the thirteenth! This makes me hesitate. What I believe ought to be done is to let these new specimens unite some friendly but now separated species, instead of compelling them to make the situation more intolerable. For to recognize thirteen species of one Mallophagan genus from thirteen species of owls—for that happens to be the exact number of owl species from which *Docophori* have been taken—and four of them from a single owl kind, would be unnatural, and also most inviting of ill luck! I am sure of the unnaturalness from my knowledge of the host distribution of the Mallophaga. The trouble is that the isolation of the *Docophorus* (and other Mallophagan) individuals on owls is even more effective than on most other birds, for owls are peculiarly non-gregarious and

[4] Report of Consul John F. Jewell, of Vladivostok.

offer unusually little opportunity for the passage from host to host of the wingless parasites. There is thus all too little cross-breeding, and family idiosyncrasies get all too easily preserved and made the basis of species separation. What I propose to do then, in a forthcoming systematic paper on the Mallophaga, is to reduce the number of species of owl *Docophori* and of some other similarly expanded groups. This present note is simply notice to that effect, with a suggestion of the biological reason why.

VERNON L. KELLOGG
STANFORD UNIVERSITY

ŒNOTHERA AND CLIMATE

IN their interesting account of a recent visit to Bartram's locality for *Œnothera grandiflora,* at Dixie Landing on the Alabama River, Professor de Vries and Mr. Bartlett[1] say:

> Neither *Œ. grandiflora* nor *Œ. Tracyi* has heretofore been known as other than annual, and the abundance of rosettes which would obviously not flower this season was therefore a point of great interest.

In growing *Œ. grandiflora* and many other Œnotheras under a variety of climatic conditions, I have been greatly struck by the different ways in which they respond, both as regards the annual or biennial habit and the time of flowering in a given season. Seeds of a series of *Œnothera grandiflora* forms from Birkenhead, England, which I planted in a tropical greenhouse at the University of Chicago in July, 1907,[2] were grown under tropical conditions, the plants remaining rosettes throughout the winter and flowering in May, 1908. *Œ. Lamarckiana* forms treated in the same manner nearly all remained rosettes indefinitely, *i. e.,* for about twenty-two months, until the experiments were suspended. This difference in behavior I attributed to the fact that *Œ. grandiflora* is adapted to a more southern climate than *Œ. Lamarckiana.* In 1909 I observed typical rosettes of *Œ. grandiflora* growing in midsummer (probably as escapes) in uncultivated land of the Missouri Botanical Garden. Hence in that climate also the plant is biennial. From these and related facts, together with the observations of de Vries and Bartlett, it is probable that all the *Œnotheras* of this group are biennial in their native localities.

When grown from seeds planted in the greenhouse in January or March, *Œ. grandiflora* often omits entirely the rosette stage, beginning to form a stalk when quite a young seedling. In my cultures under these conditions the characteristic leaf-type of the mature rosette is always omitted. The plant, therefore, unlike the *Œ. Lamarckiana* forms, becomes annual by shortening its life cycle.

Plants of *Œ. grandiflora* grown from seeds from Dixie Landing behaved in still a different way in the English climate this year. Seeds were sown in the greenhouse in January, and the young seedlings planted out in the end of May. They formed very imperfect rosettes but, though stem-formation began early and they grew luxuriantly, yet they failed almost completely to come into bloom, only two plants out of two hundred and twenty-one producing any flowers.

Incidentally it may be mentioned that, as I have pointed out elsewhere,[3] *Œ. grandiflora* occurred in the region of Carolina and Virginia as late as 1821 (Barton's "Flora of North America," Vol. I., plate 6). It would be worth careful search to discover if individuals do not still survive in this region, for that was undoubtedly the source of the large-flowered *Œnothera* described by Ray in the "Historia Plantarum," 1686, and which must have belonged to a race either of *Œ. grandiflora* or of *Œ. Lamarckiana.*

Seeds which I obtained from Birmingham,

[1] De Vries, Hugo, and Bartlett, H. H., "The Evening Primroses of Dixie Landing, Alabama," SCIENCE, N. S., 36: 599–601, 1912.

[2] See Gates, R. R., "An Onagraceous Stem without Internodes," *New Phytologist,* 11: 50–53, pls. 2–3, 1912.

[3] Gates, R. R., "Early Historical-botanical Records of the Œnotheras," *Proc. Iowa Acad. Sci.,* 1910, p. 108.

Alabama, through the kindness of Mr. Robert A. Love, yielded a race which behaved in the same way, and which evidently belongs to the *Œ. Tracyi* described by Bartlett.[4] The plants, which were grown at the John Innes Horticultural Institution this year, numbering 173, were very uniform and agreed in general with Bartlett's description. They were very tall and stout, much more so than *Œ. grandiflora*, and several plants showed small buds at the end of September. Certain other facts in this connection are referred to in a paper now in press in the *Transactions* of the Linnean Society.

In growing scores of wild races belonging to the species *Œ. biennis, Œ. muricata, Œ. grandiflora, Œ. argillicola, Œ. Hookeri* and others from various parts of North America, in the climate of England during the past summer, I have been greatly impressed by the constancy and the peculiarity of each race as regards such physiological characters as the strength of the biennial habit, and the time of blooming. The differences in these respects are quite as marked and constant as any morphological characters can be, and in hybrids they are frequently intermediate. Evidently each race is closely adapted to the conditions of the growing season in its own native locality; and within certain limits it is possible to predict what the behavior of a race will be when one knows the latitude and climatic conditions from which it came. The elucidation of the origin of these racial climatic adaptations in *Œnothera* is a most interesting evolutionary problem.

R. R. Gates

Imperial College of Science,
London

INHERITANCE OF THE RUSSET SKIN IN THE PEAR

The russet skin occurs commonly in the pear and it is found in amounts varying from 0 per cent. to 100 pér cent. In Ragan's "Nomenclature of the Pear"[1] are described 547 varieties having no russet, and 772 varieties having a very light to a solid russet covering. In the latter class only 16 are given as simply "russet"; however, several others, as the Bosc, should come under this head. The low number of russet individuals indicates that the russeting is recessive to the smooth-skinned condition, and that many of the partially russeted and smooth-skinned pears must be heterozygous—the dominance of the smooth-skinned condition being frequently incomplete.

The results obtained at the New York Agricultural Experiment Station, Geneva, New York, support such a postulation. In a cross between Kieffer ♀ and Elizabeth ♂, both parents having smooth skins, were obtained two russeted and ten smooth-skinned seedlings. This population is too few in number to allow one to draw definite conclusions; nevertheless, it approaches closely a simple 3:1 Mendelian segregation. In a cross between Bosc ♀ and Kieffer ♂, the ♀ parent having a russet skin and the ♂ parent carrying the russet condition as a recessive?, there were produced five seedlings—two of which were smooth-skinned and three russeted. The progeny of this latter cross approximate a 1:1 Mendelian ratio, viz., one individual is homozygous to the smooth-skinned condition and one individual is heterozygous to russeting. As a Russet Bartlett of unknown origin, differing from the normal Bartlett in no character except the skin—even in the self-sterility of the blossoms—is growing on the experiment station grounds, it is reasonable to suppose that the russet condition is due to a loss of a determining factor, for the loss of a character is much more common than the addition of a new one.

Richard Wellington

New York Agricultural
Experiment Station,
Geneva, N. Y.

[4] Bartlett, H. H., "Systematic Studies on *Œnothera*. I. *Œnothera Tracyi* sp. nov.," *Rhodora*, 13: 209–211, pl. 93, 1911.

[1] U. S. Dept. Agric., B. P. I. Bull. 126, 1908.

SOCIETIES AND ACADEMIES

ACADEMY OF SCIENCE, ST. LOUIS

A meeting of the Academy of Science of St. Louis was held at the academy building, Monday, November 18, President Englar in the chair.

Professor James F. Abbott, of Washington University, addressed the academy on "Permeability of Animal Membranes," dealing particularly with some experiments conducted during the summer on fiddler crabs.

Dr. C. H. Turner, of the Sumner High School, gave a short talk on "The History of an Orphan Colony of a Paper-making Wasp"; and Dr. H. M. Whelpley spoke on "Indian Miniature Axes and Celts," illustrating his remarks with numerous interesting examples.

Professor F. E. Nipher, of Washington University, presented some results of his experiments on "The After Effects in an Aluminum Wire used in Electric Discharge."

Since making a communication to the Academy of Science of St. Louis on November 4, experiments have been made in the study of the creeping of an aluminum wire through which a rarefaction wave is sent.

When a fresh wire is used, the wire creeps in a direction opposite to that of the corpuscular displacement.

After the discharges from a condenser of large capacity have passed through the wire for fifteen or twenty minutes the position of the wire is reversed; no other change being made, the wire creeps in the opposite direction in space. This has been repeated many times.

On the other hand, if the polarity of the influence machine is reversed the wire creeps in the same direction in space.

The end of the wire which is in advance in the motion of the first case is in advance in the two subsequent cases.

In the two latter cases the wire creeps toward the positive terminal. The discharge terminals at the wire were in the form of rings of large copper wire, which closely encircled the aluminum wire. The long spark was in the conductor leading to the positive terminal of the machine, about ten feet distant. Some preliminary experiments seem to indicate that this after-effect can not only be eliminated, but that it can be reversed.

Such effects have not been observed in copper wires, but it is possible that a decrease in the sensitiveness of response of the wire was due to this cause, and not to frictional contact in the grooved supports, as had been supposed. It was at first thought that the effects described might be explained as differential end or point reactions between the ends of the wire and the air and other surrounding matter. The ends of the wire were, however, bent downward, so that they point in a direction at right angles to that in which the wire creeps. Either end may be bent downward, the other pointing either in the direction of motion, or in the reverse direction, without affecting the direction in which the wire creeps, in any material way. This apparently eliminates end effects from any part in these very remarkable results, and it is entirely possible that some of the conclusions heretofore published may require modification.

It would not be surprising, in view of these results, to learn that the resistance of this wire depends upon the direction of flow of the current.

GEORGE T. MOORE,
Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

THE 83d regular meeting of the society was held at the Cosmos Club November 12, 1912. The program included the following papers:

A Portrait of Linnæus: Dr. J. N. ROSE.

Dr. Rose exhibited an engraved portrait of Linnæus which had recently been presented to the Smithsonian Institution by Captain John Donnell Smith, of Baltimore, who had previously given to that Institution his magnificent herbarium and library. This portrait is one rarely seen in this country, being a mezzotint of one of the earliest portraits of Linnæus, the original being a replica of Hoffman's famous picture showing Linnæus in Lapland dress, of which the original is now the property of the Clifford family. This replica was known to have been in the possession of one Thornton as late as 1811; but its whereabouts now is not known.

Dr. Rose also called attention to the large collection of portraits of Linnæus in the possession of the Linnean Society, and also to the work of Tycho Tullberg, "Linneporträtt," a quarto volume of 185 pages with 25 portrait plates.

"Rough-bark" Disease of the Yellow Newtown Pippin: Mr. JOHN W. ROBERTS.

Botanizing in the Region of the Natural Bridges of Southeastern Utah: Dr. P. A. RYDBERG (by invitation).

THE 84th regular meeting was held at the Cosmos Club on December 3, 1912. The program included the following papers:

Summary of Studies of Glomerella (with lantern): Dr. C. L. SHEAR.

Probable Origin of Maize (with lantern): Mr. G. N. COLLINS.

The Effect of Lime on the Alkali Tolerance of Wheat Seedlings (with lantern): Dr. J. A. LECLERC and Mr. J. F. BREAZEALE.

C. L. SHEAR,
Corresponding Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

AT the meeting of the society in the New National Museum on Tuesday afternoon, November 19, President George R. Stetson in the chair, Mr. James Mooney, of the Bureau of American Ethnology, lectured upon "The Gaelic Language of Ireland."

The lecturer outlined the history of the Keltic nations, of whom the Gael of Ireland and Scotland are a part, from their first acquaintance with the Greeks about six hundred years before Christ, down to the storming of Rome in 390 B.C.—the earliest authenticated date in Roman history—their alliance with Alexander the Great, their invasion of Asia Minor and colonization of Galatia in 278 B.C., and the final subjugation and Latinization of the continental Kelts by the Romans about the beginning of the Christian era.

Gaelic is the oldest living language in Europe, unless we except modern Greek, and it closely resembles Latin in many of its roots.

The Gaelic colonization of Ireland probably dated as far back as 1000 B.C. The island was known to the Greeks under a form of its native Gaelic name of Eire as early as four centuries before Christ. The ancient annals mention several earlier races or colonizations, the most important being the Firbolg, probably a part of the Belgæ of the continent. They continued to exist as a distinct people under their own chiefs up to the sixth century or later.

The alphabet of pre-Christian Ireland was the Ogam (Ogum), a system of straight lines or dots ranged along either side of a base line, and somewhat resembling a cross between the Morse alphabet and the cuneiform inscriptions. It was used chiefly for monumental inscriptions, and continued in use to some extent up to the tenth century. The modern Gaelic alphabet, consisting of seventeen letters, is an adaptation from the Roman.

Mention was made of some of the most ancient manuscripts, some of which have been already translated and others of which are now under translation by the Irish Texts Society. Under the Penal Laws, from 1691 until about 1800, the whole native population was practically debarred from education. Under the so-called National School System, established in 1831, the national language continued to be proscribed, resulting in its rapid decline. The great famine of 1845–7 with the ensuing wholesale emigration reduced the Gaelic-speaking population by nearly one half within twenty years, the great majority of those remaining being entirely illiterate. In 1878 the first concession to the native language was made by the national schools. In 1893 the Gaelic League, under the presidency of Dr. Douglas Hyde, began an active propaganda for the restoration of the language to its proper status, with the result that it is now taught in 3,000 of the 8,000 governmental "national" schools, as well as in a large number of private and denominational schools, a whole flood of modern Gaelic literature covering every subject of intellectual interest is coming from the press, and the Gaelic language has been made an essential for matriculation in the new National University of Ireland beginning with 1913. Out of its own funds the league also maintains ten normal colleges for the training of teachers in the language, in several of which schools the entire course of instruction is through the Gaelic. The census just completed shows that Gaelic is still the home language of nearly 600,000 persons in Ireland above the age of three years.

Outside of Ireland the Gaelic speakers in Scotland, England, the United States, Canada and elsewhere probably number considerably over a million. Prince Edward Island and adjacent parts of Nova Scotia have a compact body of about 100,000, mostly descendants of emigrants from the Hebrides. In this country Gaelic instruction is now conducted in several universities and a translation of the Rubaiyat, in Gaelic language and type, was recently published in Chicago.

W. H. BABCOCK

THE ELISHA MITCHELL SCIENTIFIC SOCIETY

THE 202d meeting of the society was held December 10 in Chemistry Hall, University of North Carolina. The following program was presented:

"Notes on the Construction of the Crest-of-the-Blue-Ridge Highway," by Mr. T. F. Hickerson.

"Zonation in the Chapel Hill Stock," by Mr. Collier Cobb.

JAMES M. BELL,
Recording Secretary

CHAPEL HILL, N. C.

SCIENCE

FRIDAY, JANUARY 31, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

COMPARATIVE MEASUREMENTS OF THE CHANGING COST OF LIVING[1]

THE changing cost of living is a fundamental cause of many reactions in the complexes of social phenomena. In fact, it is probable that an economic interpretation of many important historical movements may be developed from future study of such events as possible effects of this probable fundamental cause of radical movements in human societies, such as extensive revolutions and even international wars.

Political economists, at any rate, should hold always before them the idea that mankind is subject first to the primary economic problems of self-maintenance. The changing cost of living is another phrase to denote in a civilized society this factor of relative self-maintenance which is so important in the study of the more primitive societies. Thus, on the side of the consumption of commodities, we may measure the changing cost of the primary necessities in terms of the prices of the markets.

With the development of markets and with the establishing of standard grades for leading commodities, it becomes possible to fix rather definitely comparative prices of all of the more important commodities. As a result, we may compare with a considerable degree of accuracy the fluctuations in the changing cost of living over a series of successive years. Of course, the greater problem of constructing an index number of relative welfare which shall

[1] Address of the vice-president and chairman of Section I, American Association for the Advancement of Science, Cleveland, January 3, 1913.

combine in some rational way the general concepts of the cost of living and of the average rates of income may lead eventually to many interesting conclusions, but this problem at the present time is extremely difficult.

In this paper, which is divided into three parts, I shall present, first, the results of original computations of two series of index numbers for American prices. Hitherto, the purpose of index numbers has been chiefly to measure the changing cost of living in order to compare the relative conditions of successive years for the same country.

In the second part of this paper, I have endeavored to present some comparative measurements of the changing cost of living for various countries at the same time, and, incidentally, to devise an international index number, based on some index numbers of the United States, England and France. In the third part, it is interesting to consider briefly various remedies for the instability of the price level, and to inquire whether a society has not within its control indirect methods of reducing absolutely the cost of living—methods which may prove more fruitful than some of the direct methods which have been suggested from time to time in order to secure a relative rather than an absolute reduction.

It is unnecessary to present a technical description of my two series of index numbers for American prices which have been described in the *Quarterly Journal of Economics*,[2] and elsewhere.[3] Suffice it to state that the general method of the Sauerbeck system has been adopted along with certain modifications, some of which were suggested by Forbes and others occurred as practical necessities of the computation.

The two index numbers may be described as the averages of the percentages of the prices of fifty important commodities expressed in terms of the average prices of the years, 1890 to 1899, so that the average price level of the years 1890 to 1899 is the base or one hundred per cent. Two systems of weighting have been used. My first series follows Sauerbeck in the use of the simple arithmetical average. The second series was intended as an approximate continuation of the Dun index numbers which ended in 1907, and which have been published since 1910 as the Gibson index number. The same arbitrary weighting is used in the two series, although the Dun numbers were based on three hundred and fifty commodities and the Gibson on fifty leading commodities. Mitchell[4] has shown that my method of continuing the Dun numbers by using fifty primary commodities rather than three hundred and fifty commodities, many of which are derivative, produces an average difference on the basis of past years approximately of two per cent. The fifty commodities consist of the leading articles of commerce which are most capable of accurate grading.

In the succeeding table,[5] the relative weighting of the various groups, such as foods, clothing, minerals and other commodities, is presented in contrast for various index numbers, in order to suggest the cause of the slight differences which occur in the results reached by the various numbers.

The more heavily the food group is weighted, the more the total index number of all commodities tends to advance. This

[2] *Quarterly Journal of Economics*, August, 1910.

[3] Pamphlets on Index Numbers, published by the Gibson Publishing Co., 1910–11.

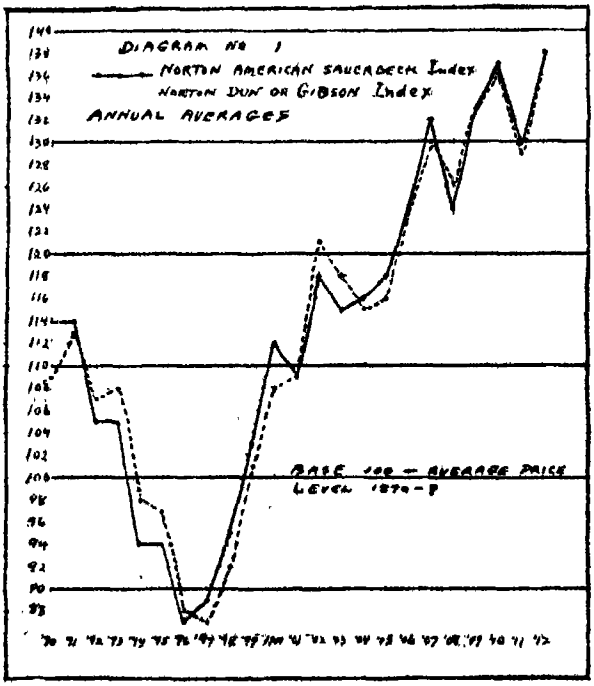
[4] *Quarterly Journal of Economics*, November, 1910.

[5] "How Index Numbers are Made," by F. C. Croxton, *Journal of Commerce*, June 2, 1910, and Norton, "Weighting of Index Numbers," June 9, 1910.

[illegible]ING WEIGHTING OF GROUPS IN [illegible]RIOUS INDEX NUMBERS

Groups of Commodities	Sauerbeck's English Index Number, Per Cent.	Norton's American Sauerbeck Number, Per Cent.	Norton's Gibson or Dun Number, Per Cent.	Bradstreet's Index Number, Per Cent.	Bureau of Labor Index Number, Per Cent.
Clothing	42	44	50	37	26
Food	18	18	18	10	29
Other	40	38	32	53	45

point will be discussed later in this paper. On the other hand, if a large weight is given to manufactured articles, which is the case in the United States Bureau of Labor index numbers, the tendency is to reduce the extent of advance. The group weighting influences the results more than the fluctuations of single commodities, because all commodities of the food group are in a large measure in competition through possible substitution by consumers. The following tables, which are represented by diagrams, disclose the annual averages for the period, 1890 to 1912. The first column contains the American Sauerbeck index number,[6] the second column the Dun and Gibson series, and the third column the Dun and Gibson series reduced to the same base as the American Sauerbeck which is the average price level of the years 1890 to 1899 as one hundred per cent. This table is represented graphically by diagram No. 1.



The annual average difference of the two index numbers is two per cent.

To summarize the general movements, a five year average table has been prepared. This table shows how little the weighting has influenced the results in the two series, because the weighting for the food group differs in the two numbers to a less extent than in the case of the other possible comparisons.

[6] Norton's "Lessons Suggested by the Experience of the French People and of the Bank of France," *Proceedings of the Academy of Political Science*, January, 1911.

TABLE OF ANNUAL AVERAGES OF TWO INDEX NUMBERS FOR AMERICAN PRICES

	American Sauerbeck Index Number	Dun or Gibson Index Number	Percentage Dun Index Number
1890	114	92	109
1891	114	96	113
1892	105	90	107
1893	106	91	108
1894	94	83	98
1895	94	82	97
1896	87	74	88
1897	89	73	87
1898	95	78	92
1899	103	85	101
1900	112	91	108
1901	109	92	109
1902	118	102	121
1903	115	100	118
1904	116	97	115
1905	118	98	116
1906	124	105	124
1907	132	110	130
1908	124	106	126
1909	133	112	133
1910	137	115	136
1911	130	109	129
1912	138	117	138

TABLE SHOWING THE FLUCTUATIONS OF THE FIVE-YEAR AVERAGES OF THE TWO INDEX NUMBERS FOR AMERICAN PRICES

	Dun-Gibson	Norton-Sauerbeck
1890–94	107	106
	− 14	− 12
1895–99	93	94
	+ 21	+ 20
1900–04	114	114
	+ 12	+ 12
1905–09	126	126
	+ 8	+ 9
1910–12	134	135

It is clear that both series of index numbers agree rather closely in showing that we have been living in an era of a prolonged advance in the cost of living during the past fifteen years. In summary, using my American Sauerbeck index numbers, the price level of 1912 is some 59 per cent. above the level of 1896, and compared with 1890, the percentage of advance is 21 per cent.

Such instability in the average price level is unfortunate, and, whether we attribute the causes solely to forces acting on commodities or to fluctuations in the gold standard or to both causes, the central fact remains that the instability of the price level has caused many hardships to our people.

Let us now construct two index numbers by splitting up the component groups into a food index number and an "other than food" index number, using the average prices of each group, respectively, as the two bases, one hundred per cent. The purpose is to discover the relative movements of the two groups, foods and other than foods, over a period of fifty years. Using the early Dun numbers, reduced to the new percentages, we may present a rough comparison, which, I think, throws light on the situation.

What has happened becomes obvious upon inspecting the following table, which presents the conditions of the price levels of the two groups for selected years, during the period commencing in 1860 and ending in 1912.

TABLE SHOWING THE FLUCTUATIONS OF THE FOOD INDEX IN CONTRAST WITH THE INDEX FOR OTHER COMMODITIES FOR SELECTED YEARS. 1860 TO 1912

	Index Number for Foods	Index Number for Commodities Other than Foods
1860	145	155
1864	293	452
1870	195	200
1875	167	160
1880	138	155
1885	117	112
1888	126	112
1889	124	112

The above statistics are as of January 1.

1890	102	117
1891	121	107
1892	107	107
1893	110	107
1894	102	95
1895	100	95
1896	81	95

1897	83	88
1898	93	93
1899	100	102
1900	105	112
1901	105	114
1902	126	117
1903	117	119
1904	105	112
1905	112	121
1906	119	131

The above statistics are as of July 1.

1907	121	140
1908	129	124
1909	140	126
1910	140	133
1911	186	124

The above statistics are annual averages.

1912	148	131

The figure for July, 1912, is given as the last comparison.

From the average of the low years, 1896–1897 down to 1912, the food group has advanced 80 per cent. and the "other than food" group 43 per cent. Thus, compared with the two low years, 1896–97, foods have advanced nearly twice as much as other commodities. Consequently, the hardships experienced by the classes of the smaller incomes have been very great throughout the world, inasmuch as in all family budgets the percentage spent for foods increases as income diminishes.

But, if we take as representative the figures of 1860 and 1880, leaving out of account the years of the Civil War and of suspension of specie payments, we have 142 for foods and 155 for other commodities. Comparing the conditions of the years 1860 and 1880 with the low years 1896–97, we might have said in 1896 and 1897 that foods had fallen 60 points and other commodities 63 points, or turning the comparison about, food prices as well as other commodities in 1860 and in 1880 were approximately 70 per cent. higher in 1860 and in 1880 than in 1896–97. In short, food prices are now on the level of 1860 and 1880 and other than food prices are probably 15 per cent. lower.

In summary, since food prices during the past fifteen years have advanced in the United States nearly twice as much as the "other than" food commodities, it is unlikely that the tariff has played so important a part as other causes. Possibly, the tariff is indirectly responsible to some extent in over-stimulating industries of the "other than food" group, and in this way helps to contribute to a deficit proportion of agricultural population.

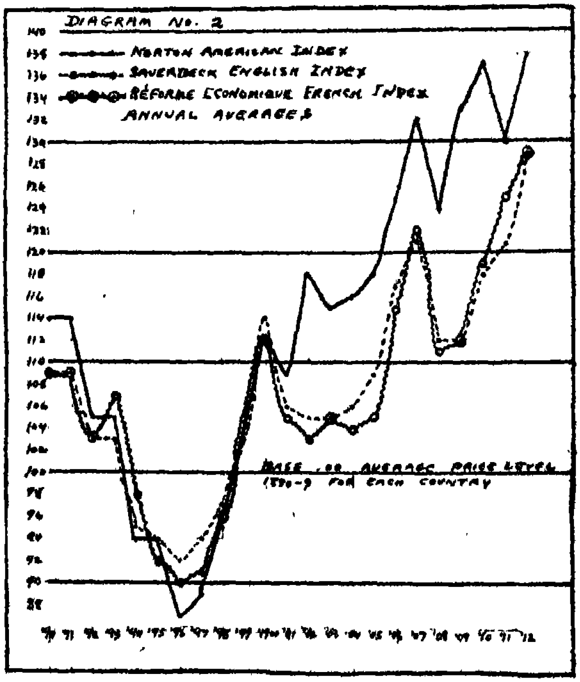
It seems more probable, however, that the great drop in prices which occurred from 1880 to 1896 represents in part the effects of the unprecedented railroad construction of those days and of the utilization of new inventions in farm machinery, two causes which were at work and must have cheapened the average cost of production of the food group. Naturally, rural population was displaced by farm machinery and we know that thousands of acres of farm lands in the east were rendered of less value by the falling prices, resulting from the application of these two great lines of inventions. As food prices fell and immigration continued on a large scale the wage rates fell, and reduced wages made the cost of production of other commodities lower and naturally the prices went down in sympathy with the lower cost of production.

Food prices are fundamental and "other than food" commodities are derivative through the wage scales which vary with the cost of food. Further, all statistics indicate a steady drift of population away from the food industries to the "other than" food industries, suggesting that the opportunity to secure steady work by labor less securely attached to land has been better in the "other than food industries,"

The various movements to extend agricultural credit, to improve systems of distribution and to furnish instruction to the agricultural classes are doubtless in the right direction. But, it is difficult to see how these movements, beneficial as they may prove, can much more than keep pace with similar movements making urban work more productive, such as rapid transportation, trade schools, night schools, etc. In fact, the simple economic force to increase the relative production of foods is, after all, a continued higher level of food prices which will tend to raise farm wages and to stimulate increased production generally in all of the land pursuits.

In order to make comparisons, Sauerbeck's index number for England and the index number[7] for France are reduced to percentages of their own averages for the years, 1890–99, respectively. Thus, the three numbers for each year are simply percentages of the average price level of the decade, 1890–99, for each of the countries. Diagram No. 2 represents the fluctuations of the index numbers of the three countries.

This method affords a system of comparative measurements of the changing cost of living for different countries, but does not necessarily afford a basis for the measurement of the absolute cost of living in different countries. The latter is, also, an important problem which should be undertaken, the solution of which will require patient critical work in the determination of equal grades of commodities in various countries.



We come now to the second part of this paper, the comparative measurements of the changing cost of living, geographically considered. In the following table, illustrated by diagram, we may contrast the changing cost of living in the United States, England and France.

[7] Published monthly by *La Réforme Économique*.

The fourth column contains the records of my international index number which is simply the average of the three preceding numbers for each year. It is interesting to note that American prices, commencing in 1902, advanced much more rapidly than did the price levels of foreign countries, but in the years 1911 and 1912 the margin of difference was considerably reduced.

TABLE SHOWING INDEX NUMBERS OF THE UNITED STATES, ENGLAND AND FRANCE

	United States Norton Sauerbeck	England Sauerbeck	France Reforme Economique	Norton International
1890	114	109	109	111
1891	114	109	109	111
1892	105	103	103	104
1893	105	103	107	105
1894	94	95	98	96
1895	94	94	92	93
1896	87	92	90	90
1897	89	94	91	91
1898	95	97	96	96
1899	103	103	105	104
1900	112	114	112	113
1901	109	106	105	107
1902	118	105	103	109
1903	115	105	105	108
1904	116	106	104	109
1905	118	109	105	111
1906	124	117	115	119
1907	132	121	122	125
1908	124	112	111	116
1909	133	112	112	119
1910	137	118	119	125
1911	130	121	125	125
1912	138[8]	129[8]	129[8]	132[8]

We are led by our system of comparative measurements of the changing cost of living to the conclusion that world-wide causes are primarily responsible for the prolonged advance in the cost of living. It is probable that accurate statistics would show for India, China, the Argentine, in fact for all countries of the world which are connected by commercial relations, quite similar conditions. My international index number for 1912 shows an advance of 46 per cent. over the low year 1896, in comparison with 59 per cent. for the United States, 40 per cent. for England and 43 per cent. for France. It should be noted that the United States numbers have advanced considerably more than the index numbers of foreign countries. But we should remember that commodities "other than" food advanced 49 per cent. in the United States, which is on a parity with the advances of all commodities for England and France.

[8] Average based on first ten months.

TABLE AFFORDING COMPARISONS OF 1896 AND 1912, AND 1880 AND 1912

	Advance 1896-1912 Per Cent.	Advance 1880-1912 Per Cent.
United States, foods	83	7
United States, other than foods	49	—15
United States, all groups	59	— 6
England, all groups	40	— 3
France, all groups	43	

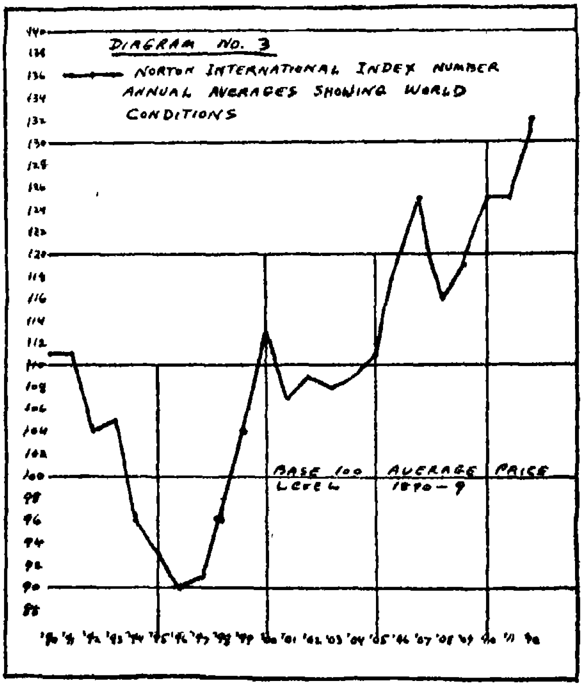
The extraordinary advance occurs in the food group of the United States, and it is quite possible that this represents several causes, some of which are technical, some of which are national and some are connected with the chain of sequences produced by an increasing production of gold. It is plain that international causes are at work. During sixteen years following 1880, world prices fell, and during sixteen years following 1896, world prices rose. It is interesting to note that independent computations show that after thirty-two years prices in the United States and in England have recovered very nearly the entire amount of the decline which reached the low point in 1896, and that now world prices are upon an approximate parity with those of 1880.

An excellent opportunity is afforded the recently appointed Industrial Commission to determine the rates of wages prevailing

in 1912 in comparison with 1880, because the cost of living conditions in the two years are very much alike and the years are far enough apart in time to furnish an excellent basis for sound conclusions regarding the relative rates of income of all classes of labor. The results would probably surprise those economists who distrust the possibilities of social progress.

finally recommended this plan to congress. Endorsements have been given by resolutions of the New York Chamber of Commerce and more recently by the International Congress of Chambers of Commerce of the world. The Sulzer bill, providing for such a commission, is now before congress.

The work of such an international com-



In 1907, the writer proposed the appointment of an international commission[9] to study the causes of the advancing price level, believing international causes were chiefly responsible. In 1912, as a result of the Washington meetings, when Senator Burton, vice-president of the American Association for the Advancement of Science, read a paper on the causes of the high prices and Professor Irving Fisher spoke before the American Economic Association in favor of the proposition, President Taft

[9] *Yale Review*, 1906, and *Moody's Magazine*, 1907.

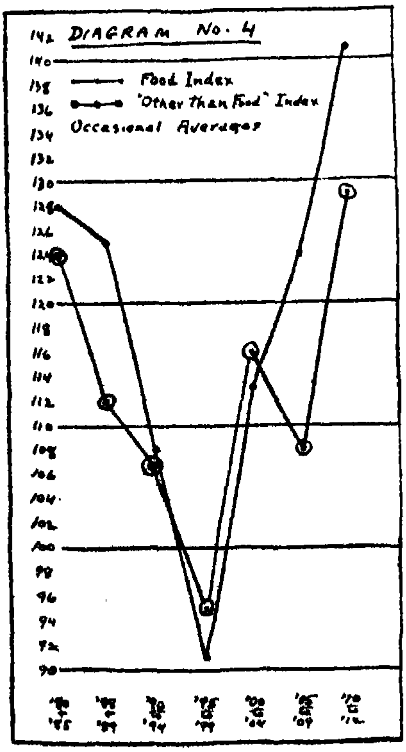
mission on the cost of living might well include the computation of a series of identical numbers for the principal countries of the world. Such index numbers should disclose the absolute as well as the relative changing cost of living as measured by fifty to one hundred leading commodities, by providing for identical commodities, identical grades and identical weighting. Such an investigation is quite as proper for the Carnegie Institution or for the United States Bureau of Standards to undertake, inasmuch as such measurements of price levels are not only very central,

but also pressing problems of economic research.

If a complete and thorough investigation should be undertaken to show the relations of the price movements of the principal countries, it is probable that the composite result expressed in the form of an international index number would not differ greatly from my international index number in statistical significance. The international index number is represented by diagram No. 3.

What would this result mean? I think that we should have in a well-defined form an approximation to those two concepts concerning which Jevons wrote, namely, first, an international multiple standard of value, and, second, a method of achieving the use of international money by making the present currency of all nations token money under the new standard of value.

Since we hold that the evidence shows that international causes are largely responsible for the advance in prices, we may omit consideration of many of the remedies which have been proposed from time to time which, if applied, would be essentially local in their operation.



What are the international causes which could have produced this common rise of more than forty per cent. since 1896 in three countries, and what could have been the common international causes for the fall in prices of the period, 1860–1896? The writer believes that the international causes are three in number. First, cheaper transportation was responsible for a part of the decline, 1880–1896, and the cessation of railroad building on a large scale coupled with increasing consumption resulted in the recovery following 1896 in some part. Second, extensive use of farm machinery lowered the cost of production throughout the world and the use of labor-saving machinery on farms resulted in a relative displacement of farm labor, causing the relative exodus from the agricultural occupations. This caused a part of the decline in food prices down to 1896. This table of averages of food prices in comparison with the prices of other commodities indicates what have been the changes in the two groups by five-year periods. Diagram No. 4 discloses the trend of these averages.

TABLE SHOWING FIVE-YEAR AVERAGES OF FOOD INDEX AND "OTHER THAN" FOOD INDEX

1880 and 1885 ...	128		124	
		— 3		— 12
1888 and 1889 ...	125		112	
		— 17		— 5
1890–94	108		107	
		— 17		— 12
1895–99	91		95	
		22		21
1900–04	113		116	
		11		— 8
1905–09	124		108	
		17		21
1910–12	141		129	

Naturally, lower prices for foods resulting from cheaper transportation and the displacement of farm labor by agricultural machinery resulted in a world-wide relative urban movement. Undoubtedly, several years of continued high food prices will prove the most efficient cause to encourage an increased production of foods. All legislation making agricultural credit available and affording opportunities to acquire land on favorable mortgage conditions will contribute to this end.

The third international cause is undoubtedly the increased production of gold[10] commencing in the late nineties. Just as excess of paper money in the Civil War period inflated prices, so the excessive gold supplies have inflated international prices, and all credit devices economizing the use of gold have helped to magnify the tendency towards inflation. Possibly, the greater advance in food prices of the United States is due to the greater influences of the first two international causes in the United States, and the so-called gold influence may be responsible for the larger part of the common advance. However, the relative importance of the three international causes may not be accurately estimated.

But the facts remain that the instability of the international price level is a disturbing element and the difficulty is that we measure all commodities in terms of one commodity rather than in the terms of fifty or more important commodities. In 1910, the writer recommended the establishment of an optional multiple standard,[11] possibly by the Bureau of Standards. In referring to this proposal, the Massachusetts Commission on the Cost of Living says:

It is hard to see how any harm could come from giving official aid to the maintenance of such a standard for the use of any borrowers and lenders who chose to adopt it. In the event of a long continuance of the upward movement of prices, its use might prevent serious injustice and great hardship. We recommend that our senators and representatives consider the expediency of advocating its establishment.

The two classes which suffer most by the instability of the price level are wage earners and investors.[12] If wages were payable in the multiple standard, wages would fluctuate with cost of living and strikes would be diminished to a very great extent. If long time obligations were expressed in the multiple standard, creditors and debtors would exchange equal amounts of purchasing power. Now, all of these classes—the manufacturers, the labor unions, the bankers and the investors are intelligent. Why not leave the determination of the standard to agreement, and as a first step simply create an optional multiple standard which could be used when specified in wage contracts and in long time obligations.

The reasonable basis of an optional multiple standard would win its way and the economic benefits experienced would counsel its extension. By proper organization of clearing houses under a national clearing house,[13] by regulation of storage-warehouse warrants and the clearances of all classes of stock and produce exchanges, all transactions could be made either by the present currency made token money under a multiple standard, or by clearances direct in the optional multiple standard, since the holder of one unit of the optional multiple standard could convert into the value of any other commodity, if all prices

[10] Norton's "Gold Flood," *Cosmopolitan Magazine*, June, 1910.

[11] Norton's "The Remedy for the High Prices," *Independent*, February 10, 1910.

[12] Norton's "Stocks as an Investment when Prices are Rising," *Securities Review*, September, 1912.

[13] Norton's "Central Bank as a Federal Clearing House," *Moody's Magazine*, September, 1910.

were expressed in terms of the optional multiple standard, which involves simply a change of or a new definition of the dollar. This would be the final result, long anticipated by the economists. I quote from Patron's monograph on the Bank of France, prepared for the Monetary Commission:

The interesting evolution of exchange which we are witnessing and which is familiar to everybody seems to be leading us, after the well-defined periods of barter and money, to a system of mere clearing of balances. All exchange operations would then be settled by simple book transfers. Coin reduced to money of account, would cease to play any real part. Economists are ever thinking of a return to barter, which would complete the cycle, bringing us back to the original state after thousands of years and combinations of all kinds. Such would be the course of this evolution.

But, as changes in monetary standards come very slowly, because men are unwilling to change the old landmarks without most careful investigations, we do not anticipate that the vision originally seen by Jevons will come to pass at once, even though the economists are again discussing this question after the lapse of many years.

If prices continue to mount actively, the agitation for such a change will occur with increasing force. But, we must remember, so far as the gold factor is concerned, that there are eastern nations with vast populations, capable of absorbing large quantities of gold under the stimulus of the western learning which is working as a yeast of progress among them. Further, we can steady prices and produce a declining tendency by requiring a larger proportion of gold in the reserves of the banks. This would at the same time strengthen the whole credit system. If we should go farther and require minimum flexible[14] reserves, higher in dull seasons and lower in active seasons, and incidentally higher on the average, as just suggested, a considerable fluctuating tendency would be eliminated.

[14] Norton's "Statistical Studies in New York Money Market," 1901.

After all, the Fabian policy lies before us, and looking ahead, it is probable that the agitation over this subject will be largely influenced by the course of commodity prices during the coming two years. This diagram discloses the quarterly fluctuations of my new international index number for the past five years. It is probable that we have passed the high point for two years or more, and that lower prices are now in order.

TABLE OF MONTHLY INDEX NUMBERS—NORTON INTERNATIONAL SERIES

	1907	1908	1909	1910	1911	1912
Jan. to March	125	117	116	125	124	129
April to June	127	116	118	125	124	135
July to Sept.	126	115	119	125	125	132
Oct. to Dec.	122	115	121	123	126	

If this position shall turn out to be correct, we shall be in a better position two years from the present time to estimate whether the growth of population, the absorption of gold by eastern nations and the higher level of prices shall have overtaken the rate of increase of gold production sufficiently to produce an era of falling prices. When this occurs, as it will occur, sooner or later, we shall have the reverse agitation of the agricultural classes against falling prices such as our country witnessed in the Populistic agitations of the early nineties.

The money question, which has been a political issue, constantly changing in form and exceedingly disturbing to business, will continue to be with us so long as the instability of the price levels continues.

One result of the prolonged advance in the cost of living has been to emphasize the necessity of "economy," not only personal,

but also "political," quite in the original sense of political economy. The very name of the movement which in a way is a constructive reaction from the economic stimulus of a lessened purchasing power is significant. I refer, of course, to the conservation movement. The word conservation, although vague, stands for the diminishing of wastes. In the conservation movement, we have a return to the original purposes of "political economy." The items which make up the cost of living as represented by an average family budget suggest plainly the directions in which the prevention of wastes may prove most fruitful. In the attempt to reduce the absolute cost of living, society wages an eternal warfare against the destructive wastes of nations,[15] which are preventable war, preventable ignorance, preventable sickness, whether physical, intellectual or moral, preventable death, preventable accidents to life and property, and preventable lack of opportunity which may delay or prevent the productivity of exceptional minds like those of Edison and Burbank, which exist in all degrees in certain proportions in the population. The latter waste is the greatest waste which society still permits. The public school system is an institution created to furnish equal opportunity for education, but it is probable that a system of vocational guidance for exceptional children, *i. e.*, above the average, would prove an extremely profitable policy for a nation to undertake on a large scale.

If we admit that in a population some are exceptional beyond others in intelligence, in foresight and in inventive capacity—and we know this to be true by the prevalence of idiots, insane persons, criminals and paupers, classes below the average—it follows that the larger the population of the same strain, the greater will be the number of exceptional minds above the average. It is self-evident that the national dividend of a better civilization is created by the exceptional minds of a nation for the higher utility of all. We reduce absolutely, not relatively, the cost of living when we discover a cheaper method of controlling the matter and the forces of the world. Thus, a natural tendency to progress[16] is inherent in an increasing population, unless checked by the destructive wastes of nations. Nor can we overestimate the importance of ethical and hygienic standards in the study of political economy. Our measurements and standards of utility must be based on ethical and hygienic values rather than on conceptions of ophelimity or desirability.

By ethical standards, we mean to include among others the more enlightened conceptions of jurisprudence, and by hygienic standards the well-balanced judgments of enlightened medical and sanitary experts. But the guidance of present statistics of the cost of living supplemented by vital statistics is essential to a balanced judgment and the lack of accurate statistics on social and economic subjects is well known. Without measurements, our conclusions must be vague.

J. Pease Norton

New Haven, Conn.

PLANS FOR A GREATER UNIVERSITY OF MONTANA

Between forty and fifty prominent citizens of all parts of the state of Montana met at Helena, December 23, and organized the Association for the Creation of a Greater University of Montana. This is to be brought about by the consolidation of the present iso-

[15] Norton's "Economic Advisability of a National Department of Health," *Journal of American Medical Association*, August, 1906.

[16] Norton's "Cause of Social Progress and the Rate of Interest," *Popular Science Monthly*, September, 1910.

lated institutions of higher learning, the university, the agricultural college, the normal school and the school of mines at some city which is desirably situated. The plan is supported by the proposed conversion of the plans and equipment that would otherwise be abandoned into a system of polytechnic high schools.

A comprehensive outline of the change sought to be effected is given in the constitution and by-laws of the association, organized at that time before the meeting of the board. This follows:

The name of the organization shall be "The Association for the Creation of a Greater University of Montana."

The purpose of this association shall be:

1. To consolidate the four higher educational institutions of the state in order to prevent the educational and financial waste brought about by the maintenance of separate and isolated institutions.

2. To establish, instead of the four institutions, a greater University of Montana to be situated in or near some city suitable by reason of its railroad connections, climate and water and health conditions to be a great seat of learning.

3. To work for the creation of a splendid system of polytechnic high schools which are at the present time so much needed; this to be brought about by means of (*a*) the utilization of all the present plants that would otherwise be abandoned, (*b*) the utilization of the military post at Fort Assiniboine if the government turns it over to the state; (*c*) the establishment of similar schools in other sections of the state as they may from time to time be needed.

4. To impress on the attention of philanthropic persons, especially men of great means, the desirability of aiding the development of the University of Montana, through the provision of buildings and endowments.

5. To arouse public sentiment in favor of education and to arouse the enthusiasm of the people to the unsurpassed educational possibilities of the great commonwealth of Montana.

The state board of education, after giving a hearing to the representatives of this resolution, unanimously adopted resolutions recommending that the legislature consolidate the institutions and pledging the members to do all within their power to encompass the result sought.

THOMAS HARRISON MONTGOMERY

AT the recent meeting of the American Society of Zoologists in Cleveland, Ohio, the following resolution was submitted by Dr. A. G. Mayer on behalf of the executive committee. The resolution was then approved by a rising vote of the society.

Never has a deeper sense of irreconcilable sorrow fallen upon us of this society than that following the announcement of the death of Thomas Harrison Montgomery on the nineteenth day of March, 1912, at the early age of thirty-nine years.

Other friends, leaders in science, have gone before, but they were full of years and the labor of their lives was as a story well nigh told; but with Montgomery the tasks that lay before him were those of the greater years of life, that period of intellectual fruition for the harvest of which his years of toil and training had been a preparation.

While thus but upon the threshold of his middle years, science lost him; but irreparable as these things be, it is as our friend we mourn him most.

No ordinary motives actuated him in his scientific work, for personal ambition never clouded his simple love for truth wherever truth might lead him.

It is to unselfish men such as he that great opportunities are entrusted, and the equipment and organization of the new Zoological Laboratory of the University of Pennsylvania was a task he had all but completed, and this will serve as a fitting monument to his ability as an executive.

On the scientific side, he was the author of nearly one hundred publications, and it would be impossible to write a text-book upon the rôle of the chromosomes in the determination of sex without referring to his crucial labors in this field.

It is seldom that we see a man even far advanced in years attain to the achievement he accomplished. Yet as our friend and our companion we mourn him most, for science will and must be advanced; but to us there ever will be but one Montgomery, the generous friend, sympathetic and simple, Montgomery the gentleman who loved us and whom we loved.

W. C. CURTIS,
Secretary

SCIENTIFIC NOTES AND NEWS

The Elisha Kent Kane gold medal of the Geographical Society of Philadelphia was presented to Professor William Morris Davis, of Harvard University, on January 28. On that evening Professor Davis made an address on "Human Response to Geographic Environment," inaugurating the Heilprin memorial lectures. Professor Davis will receive the Culver medal of the Geographic Society of Chicago, at the annual dinner on February 19.

Professor George Herbert Palmer, Alvord professor of natural religion, moral philosophy and civil polity, and Professor Francis Peabody, Plummer professor of Christian morals, have given their final lectures at Harvard University. Professor Palmer has served the university for forty-three years and Professor Peabody for thirty-eight years.

Professor George F. Swain, of Harvard University, has been elected president of the American Society of Civil Engineers.

Dr. Charles L. Dana has been elected president of the New York Psychiatric Society, and Dr. S. Ely Jeliffe, president of the New York Neurological Society.

Major E. H. Hills, F.R.S., has been appointed honorary director of the Durham University Observatory.

Sir Sydney Olivier, governor of Jamaica, has been appointed to be permanent secretary of the British Board of Agriculture and Fisheries.

David R. Kellogg, Ph.D. (Ohio State, '12), has accepted a position as research chemist in the Bureau of Mines, with headquarters at San Francisco.

Dr. R. C. Benedict has been appointed editor of the *American Fern Journal* to succeed Dr. Philip Dowell, who declined to be considered for reappointment.

Dr. A. Hrdlička, of the United States National Museum, has sailed for Peru and Bolivia, with the object of extending his former work in those countries, and securing further anthropological collections. He expects to return in April.

Dr. Rollin T. Chamberlin, of the University of Chicago, lectured on a visit to Brazil, before the Geographical Society of Chicago, on January 24.

Dr. J. Arthur Harris, of the Carnegie Institution, spoke before the Society of Sigma Xi of Washington University on January 23, his subject being "The Francis Galton Laboratory for National Eugenics and its Work."

Before the Society of the Sigma Xi of Columbia University, Professor Henry C. Sherman lectured on January 16, on "Progress and Problems in Food Chemistry."

Dr. Victor C. Vaughan, dean of the School of Medicine of the University of Michigan, addressed the Science Club of the University of Wisconsin, January 16, on "Eugenics, or Race Betterment."

The Semon lectures on laryngology were delivered at University College on January 22 and 24, by Dr. Peter McBride, the subject being "Sir Felix Semon: His Work and its Influence on Laryngology."

Mr. Francis Blake, who did important work under the U. S. Coast Survey from 1866 to 1878, and subsequently obtained distinction by the invention of the telephone transmitter and other electrical apparatus, died at his home in Weston, Mass., on January 19, aged sixty-three years.

Professor Jonathan Hyatt, known for his contributions on insect anatomy, former president of the American Microscopical Society, died at his home in New Rochelle, on December 20, aged eighty-six years.

Mrs. William Bashford Huff, formerly demonstrator in physics in Bryn Mawr College, the author of contributions to physics and mathematics, died on January 19, aged twenty-nine years. In 1898 she married Dr. William Bashford Huff, professor of physics at Bryn Mawr College.

Dr. William Howship Dickinson, a distinguished English physician and pathologist, died on January 9, aged eighty years.

Mr. B. Leigh Smith, known for his work in Arctic exploration, died on January 4, at the age of eighty-five years.

THE U. S. Civil Service Commission announces an open competitive examination on February 26, for forest pathologist, to fill a vacancy, at a salary ranging from $1,980 to $2,400 a year, in the Bureau of Plant Industry, Department of Agriculture, for service either in Washington, D. C., or in the field. On February 26 there will be examinations for scientific assistant of soil surveying in the Bureau of Soils, at salaries ranging from $960 to $1,200 a year, and for assistant irrigation engineer in the office of Experiment Stations at salaries ranging from $1,200 to $1,600.

ARTICLES of incorporation for the "Rockefeller Foundation" to administer a fund of $100,000,000 to be given by Mr. John D. Rockefeller, were passed on January 21 by the House of Representatives by a vote of 152 to 65. The measure now goes to the Senate. The bill, introduced by Representative Peters, of Massachusetts, names as the incorporators to administer the fund, John D. Rockefeller, John D. Rockefeller, Jr., Frederick T. Gates, Starr J. Murphy, Harry Pratt Judson, Simon Flexner, Edwin A. Alderman, Wickliffe Rose and Charles O. Heydt, and such persons "as they may associate with themselves." The object of the foundation is "to promote the well-being and to advance the civilization of the peoples of the United States and its territories and of foreign lands in the dissemination of knowledge, in the prevention and relief of suffering and in the promotion of eleemosynary and philanthropic means of any and all of the elements of human progress."

AT the instance of the Southern Commercial Congress the governors of some of the states are appointing two delegates each to go to Europe about April 26 and to remain there three months studying the system of rural credits and land banks there existing, with a view to adapting the system to this country.

ARRANGEMENTS have been completed by which the American agency for the following journals of the Cambridge University Press will be in the hands of the University of Chicago Press, beginning January 1, 1913: Biometrika, Parasitology, Journal of Genetics, the Journal of Hygiene, the Modern Language Review, the British Journal of Psychology and the Journal of Agricultural Science.

THE will of Alfred Samson, who died recently at Brussels, provides for an endowment of $500,000 for the Prussian Academy of Sciences and $100,000 for the Bavarian Academy of Sciences, at Berlin and Munich. The endowments are stated to be for investigations which afford a prospect of raising the morality and well being of the individual and of social life, including the history and prehistory of ethics, and anthropologic, ethnologic, geographic, geologic and meteorologic influences as they have affected the mode of life, character and morals of man.

THE Woman's Medical Association of New York City offers the Mary Putnam Jacobi Fellowship of $800 available for postgraduate study. It is open to any woman graduate of medicine. The amount of the endowment to date will permit of a biennial award, and upon the completion of the fund, this will be made annually. The fellowship will not be awarded by competitive examination, but upon proof of ability and promise of success in the chosen line of work. Applications for the year 1913–1914 must be in the hands of the committee on award by April 1, 1913.

ON February 6, 7 and 8, 1913, in the electrical laboratory of the University of Illinois, the students of the department of electrical engineering will give their triennial electrical show. Although under student management, it will be by no means wholly a student show, as many manufacturing and sales companies in the electrical trade will offer exhibits. Among the exhibits will be isolated lighting plants, heating and cooking accessories, telephone, telegraph, and wireless apparatus, lifting magnets, motor controllers, high frequency machinery and a complete electrically operated café. Student demonstrators or manufacturers' representatives will be in charge of each exhibit. One special feature planned in connection with the show is an exhibit of all types and methods of electrical lighting. This will be in charge of students of electrical illumination who will discuss with interested

visitors the best and cheapest ways of lighting their buildings. Under the general direction of Dr. E. J. Berg, head of the department of electrical engineering, a business organization composed of graduate and undergraduate students is carrying on the entire work incident to the show.

THE Wagner Free Institute of Science of Philadelphia announces a course of four free public lectures under its Westbrook Free Lectureship Foundation on Conservation of Natural Resources, as follows:

January 18—Gifford Pinchot, president, National Conservation Association, "A Glance over the Field."

January 25—Marshall O. Leighton, chief hydrographer, U. S. Geological Survey, "Water as a Resource."

February 1—Overton W. Price, vice-president, National Conservation Association, "What shall we do with our Forests?"

February 8—Joseph A. Holmes, director, Bureau of Mines, Department of the Interior, "Saving Life and Resources in the Mining Industry."

THE Ecole D'Anthropologie de Paris announces the following courses for the year 1912-13:

Anatomic anthropology: Anatomic characters of fossil man. Professor R. Anthony.

Prehistoric anthropology: Art and industry of the Magdalenians and the neolithic populations. Professor L. Capitan.

Zoologic anthropology: Appearance of man in Europe. Hypotheses as to anthropologic centers. Professor P. G. Mahoudeau.

Ethnology: Study of Mendelian heredity—facts, laws, anthropologic applications. Professor G. Hervé.

Physiologic anthropology: Intelligence in the human species, according to race, sex, age, social categories and the individual. Professor L. Manouvrier.

Comparative ethnography: Origin and evolution of clothing and ornament. Professor A. de Mortillet.

Sociology: The social maladies. Professor G. Papillault.

Anthropologic geography: Geographic relations in prehistoric and historic times. Professor F. Schrader.

Ethnography: The French colonies, Morocco, Central Africa. Professor S. Zaborowski.

Linguistics: History of linguistics, the higher languages. Assistant Professor J. Vinson.

Series of special lectures by MM. Dubreuil-Chambardel, Franchet, Kollmann and Paul-Boncour.

THE Eugenics Education Society, as we learn from *Nature*, has arranged for three courses of lectures upon the groundwork of eugenics, to be given at the Imperial College of Science, South Kensington, from January to December, 1913. In the spring term (January to March) there will be a course of twelve lectures on elementary biology, with special reference to the reproductive system, by Mr. Clifford Dobell; in the summer term (April to July), a course of twelve lectures on heredity, including evolution, genetics, and heredity in man, by Professor R. C. Punnett, F.R.S.; and in the autumn term (October to December), a course of twelve lectures on statistical methods applied to some problems in eugenics, by Mr. G. Udny Yule. In connection with the Francis Galton Laboratory for National Eugenics, a course of six lectures will be delivered at University College, London, by Professor Karl Pearson, F.R.S. (Galton professor of eugenics), Miss Ethel M. Elderton, Dr. David Heron and Mr. W. Palin Elderton. These lectures will be given on Tuesday evenings at 8 P.M., beginning February 11, 1913, and will deal with the following subjects: heredity, environment and parental habits in their relation to infant welfare; heredity of piebaldism and of albinism in man; the relation of fertility in man to social value in the parent; some points with regard to our present knowledge of heredity in cases of feeble-mindedness; the mortality of the phthisical under sanatorium and tuberculin treatments; and recent studies of heredity in dogs, and their bearing on heredity in man.

THE Berlin correspondent of the *Journal* of the American Medical Association writes that the regular general meeting of the "Leipziger Verband zur Wahrung der wirtschaftlichen Interessen der deutschen Aerzte," was held at

Leipzig on November 25. It now includes over 75 per cent. of the German medical profession, the membership being about 25,000 on October 1, 1912. The work of the association requires the services of 1,280 confidential agents and superintendents who serve without pay. During the past business year the department for exchanges of practise placed 3,600 physicians in suitable positions. The widows' fund, a fund made up of voluntary contributions, distributed to the widows of physicians $9,500. In preparation for the struggle which is expected to occur against the Krankenkassen in consequence of the new insurance law, a fund has been provided by contributions of at least 100 Marks, loaned without interest, which now amounts to more than $250,000. The loan and death bureau, founded by the association in 1910, now includes 14,000 members. This serves the double purpose of making loans to its members on sufficient security and of providing a death benefit, which varies according to the contributions from $50 to $500. The bureau has hitherto loaned about $165,000.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of the late Mrs. Lucy Wharton Drexel $70,000 is bequeathed to the museum of the University of Pennsylvania, and $20,000 to the University Hospital.

THROUGH Dr. Andrew D. White, Mr. Andrew Carnegie has given to Cornell University $25,000, which will probably be used as a student loan fund.

To parallel the work of the Deutsches Haus of Columbia University an anonymous donor has presented to the trustees the house at 411 West 117th Street as La Maison Française. The building, of which the cost is estimated at $30,000, will be used as a center for the study of French literature and civilization. Columbia University has also received a gift of $8,000 from Mr. Edward D. Adams, of New York, for the equipment of a precision laboratory for physical research, to be known as the Ernest Kempton Adams ('97S) Precision Laboratory.

By the will of Levi N. Stewart, of Minneapolis, Dartmouth College receives $75,000 and Bowdoin College and Bates College $50,000 each. All the bequests are unconditional. Mr. Stewart was a former inhabitant of Maine and a graduate of Dartmouth College.

TUFTS COLLEGE is given the residue of the estate of Miss Hannah S. Moulton, of Kensington, N. H., estimated at about $25,000, for the founding of a scholarship.

THE recommendations of President Schurman, of Cornell University, in his latest annual report as to faculty participation in the university government were considered by the board of trustees at their recent meeting. The board recognized the desirability of closer relations and greater cooperation between the faculty and the board of trustees in matters pertaining to the administration of the university's affairs and referred the matter to a committee of five, to be appointed to consider and report recommendations to the board at a later meeting, final action to be deferred until after President Schurman's return.

THE regents of the University of Minnesota have voted to refer to the university senate for consideration the plan of granting six months absence on full pay in lieu of sabbatical leave for a year on half pay. It was also voted to refer to the same body the question of members of the staff accepting outside employment without the approval of the dean and the president.

PROFESSOR LUDWIG SINZHEIMER, of the University of Munich, will join the faculty of the University of Wisconsin for the second semester, taking the place of Professor Richard T. Ely, who has been appointed lecturer at the University of London during the remainder of the year.

MR. M. J. PRUCHA has been promoted from an instructorship to an assistant professorship of plant physiology in the Cornell College of Agriculture.

JOHN W. GILMORE, president of the College of Hawaii, has been appointed head of the department of agronomy of the college of agriculture of the University of California and

will take up his work at Berkeley next September.

DR. RICHARD P. STRONG, director of the Government Biological Laboratory at Manila, and professor of tropical medicine in the Philippine Medical School, has been appointed head of a newly established department of tropical medicine in the Harvard Medical School.

DISCUSSION AND CORRESPONDENCE

ON COMPARING AMMONIFYING COEFFICIENTS OF DIFFERENT SOILS

IN the issue of SCIENCE for November 29, 1912, there appears on page 761 a special article under the above caption by Professor Chas. B. Lipman, of the University of California. The brief is devoted almost entirely to a friendly criticism of certain conclusions drawn by the writer regarding a comparison of the ammonifying efficiency of certain Colorado soils with that of soils from other stated localities. Such criticisms, when presented in the proper spirit, and there is no reason to feel that this has not been the case here, are always welcome and are often helpful.

Now, the writer admits quite freely that the fundamental facts brought out by Professor Lipman are very largely true. However, he is not willing to concede so readily that the criticisms based upon these facts as applied to the case at hand are altogether warranted.

Among Professor Lipman's comments is to be found the following:

> Despite the fact that Professor Sackett makes some qualifying statements in discussing the comparisons, he does not seem to attach importance enough to some factors of which he appears to be fully cognizant and gives no consideration to other very important factors.

In support of this statement, the critic offers the following, all of which tends to leave the impression that the writer has not taken these matters into consideration and given them due weight, in spite of the fact that statements to the contrary appear in the original publication[1] referred to:

[1] Bulletin 184, Colorado Experiment Station, June, 1912, Part I., "The Ammonifying Efficiency of Certain Colorado Soils."

> The writer (Lipman) of this note fails to appreciate the value of a comparison of the ammonifying powers of various soils as obtained by different investigators whose methods vary as much as ours do to-day.

The writer in selecting the results of the work of others for comparison was particular to choose only such as were obtained in laboratories where practically the same methods have been employed, and wherever there has been any departure from the procedure of the majority, such departure has been indicated.

On page 21 of the bulletin cited occurs this statement:

> The methods employed by the different experimenters have been practically the same, so the results should be comparable.

Again, Professor Lipman points out the importance of all investigators employing the same brand, in fact the same lot, of dried blood in comparative work, intimating that the writer has ignored this point. This would be an ideal condition, most certainly, the desirability of which no one questions, but how impractical! If investigators would submit the analysis of such materials as the above along with their reports, this would assist greatly in comparative studies. The writer is fully aware that dried blood may vary all the way from 6 to 13 per cent. total nitrogen, and had he not had clearly in mind the possible influence of its composition on ammonification, why should he have called the reader's attention to this statement on page 23 of Bulletin 184?

> With the exception of the New Jersey figures, the percentages given in Table No. 6 are based upon blood meal containing 13.05 per cent. of total nitrogen, and cottonseed meal with 7.84 per cent. total nitrogen. In the New Jersey work, Lipman (J. G.) states that the blood meal and cottonseed meal contained, respectively, 13.18 per cent. and 6.405 per cent. total nitrogen.

Unfortunately, the composition of the blood meal employed by the different investigators cited in the comparative studies, with one exception, was not given, and consequently the writer, in order to get some basis for comparison, was compelled to compute the results

given on the basis of blood meal containing 13.05 per cent. total nitrogen, such as was employed by the Colorado Station. To the end of making available more complete data for comparative studies, the writer would take this occasion to urge those who are engaged in research work to be less reluctant about giving the details of their investigations, for it is obvious that comparative work is impossible and worthless except it be carried out with a strict observance of points of technique.

Professor Lipman refers to the importance of having a large number of soils in any comparative study:

> It must also be added here that the comparison of only a few soils can not be invested with much importance, even if the soils are described by similar names.

In this matter, his point is well taken, but when the data do not exist, we must be satisfied with the information at our disposal. Moreover, it seems to the writer that a comparison of the ammonifying efficiency of twenty-seven niter soils with that of ten soils selected at random in Colorado and elsewhere should have more weight than the critic would concede.

Again, Professor Lipman writes:

> It is, of course, obvious that sandy loams may embrace soils of very widely differing natures and that no just comparison can be made between a sandy loam, so called in one district, with a sandy loam so called in another district.

If this comment is intended as a criticism of Bulletin 184, it is absolutely without foundation, for no place in this publication can there be found any statement which suggests, implies or asserts a comparison of soils on a physical basis.

The one very important factor which the writer is said to have given no consideration, and upon which Professor Lipman has dwelt at some length, is what appears to be a radical departure from the normal in the method of preparing the soil cultures for studying ammonification. Professor Lipman states that "Professor Sackett sterilizes his soils with mercuric chloride and then rinses them with sterile distilled water prior to inoculation with a *soil infusion*." Then follows a critical discussion of this method.

The writer begs to state in defense of this assertion that *no such procedure has ever been practised* in his laboratory and probably never will. This seemingly direct contradiction resolves itself into a rather amusing circumstance when it is learned that Professor Lipman has gained this erroneous impression, upon which he has grounded his chief criticism, from his failure to observe certain punctuation marks in the crucial sentence. On page 4 of Bulletin 184, this sentence occurs:

> As soon as the soils were air dry, which seldom requires more than twenty-four hours in our atmosphere, each was ground in a glass mortar, sterilized with mercuric chloride and subsequently rinsed with boiled, distilled water, and passed through a thirty-mesh wire sieve.

From this, it is perfectly clear to the writer that it is the glass mortar which was sterilized with mercuric chloride and subsequently rinsed with boiled, distilled water. However, Professor Lipman makes it the soil which received this treatment, and thereby hangs the tale.

As confirming the Colorado investigations, the writer is pleased to learn that on several occasions Professor Lipman has noted a high ammonifying efficiency in soils of California, which contain abnormal amounts of nitrate, as well as in certain soils obtained from the vicinity of Grand Junction, Colorado.

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THE TERMS SEGMENT AND SEGMENTATION IN GEOLOGY

THE terms segment and segmentation which are so conveniently and widely used in the biologic sciences have not found their way into geologic literature to a very notable extent, although they seem to be well suited to geologic science. In searching for a general term which could be applied to a minor part of the earth and having the dimensions of a solid, the word segment appeared to me as the most convenient, and on reflection I recalled

that it has already been made use of in Chamberlin and Salisbury's text-book of geology, in discussing continental and oceanic segments. If it is applicable to major elements why not to minor ones as well? The parts cut off by a fault or included between faults might be called fault segments and the terms upthrow segment, downthrow segment, overthrust segment and underthrust segment would be convenient and would obviate such expressions as "the area adjacent to the fault on the upthrow side" and others which are equally unsatisfactory. Other usages of the term would follow naturally. The Colorado plateau may be cited, as an example of segmentation by faulting.

After writing the above I read the "Report on the Investigation of the Geologic Structure of the Alps," by Willis[1] and found the following usages of the term segment:

> Each of these minor scarps is the western face of a segment of the range. . . .
>
> It is an example of major and minor thrusting with two somewhat divergent directions of displacement and with diversities of folding in the several segments.

These are the only quotations which I can cite, but there are no doubt others which may occur to the reader. The fact that geologic text-books and glossaries do not include or define the term segment is no reason against its being used, since they follow usage rather than establish it.

Geo. I. Adams

[1] Smithsonian Miscellaneous Collections, Vol. 56, No. 31, 1912.

IS THE "ACADEMIC COSTUME" WORTH WHILE?

To the Editor of Science: Early in October last I accompanied my wife to the celebration of the seventy-fifth anniversary of Mt. Holyoke College, where she graduated in 1873. I was deeply and favorably impressed with the comprehensiveness and significance of the program and with the executive ability manifested by those—chiefly women—charged with its fulfilment.

Of the several functions, however, I witnessed but one, and that only in part. The "Intercollegiate Commemoration Exercises" began with a procession of some score presidents and delegated professors arrayed in full "academic costume." The sentiments aroused by it banished all desire to remain. (The following discourses, however, were admirably reported and were read afterward with interest and enlightenment.)

At Cornell University, some years ago, as a member of a committee on the subject, I cooperated in preventing the adoption of an arbitrary requirement; when, nevertheless, parti-colored ceremonial garments were worn by most of my colleagues, I excused myself from commencement exercises; hence I was quite unprepared for the gorgeous spectacle at Mt. Holyoke.

I tried to comprehend how mature, modest, civilized and learned persons could don garments indicating, on the one hand, an assumption of superiority and, on the other, a childish delight in bright colors and startling combinations (one was so "loud" that it seemed doubtful if the wearer could make himself heard). Nor could I refrain from speculating as to how far the addition of feathers and paint might complete the barbaric *ensemble*, arouse more keenly the curiosity of the uninitiated, and more effectually dazzle the eyes of groundlings.

Since then there have been sent me colored plates of the various academic costumes according to British and American usages, some courteous letters and offers of fuller information, and a pamphlet entitled "The International Bureau of Academic Costume, Albany, N. Y., July 27, 1902." To those interested I commend the paragraphs in that publication at the middle of page 5 and near the top of page 11. Candid and careful consideration of the claims there made confirms the opinion formed when the subject was first broached, viz., excepting, perhaps, the plain gown for the first degree, obviating social distinctions, the so-called "academic costume" is ostentatious, needless, childish or barbaric, and inappropriately expensive; its rapid and general

adoption, so far from evidencing its intrinsic value and probable permanence, exemplifies the survival of simian proclivities in the human race, and swells the category of peculiar "college customs" which, like the Indian of the traditional cowboy, are good only after they are dead.

It may be urged that educators constitute a "standing army" in conflict with ignorance. But there is no real analogy between their duties and those of soldiers, firemen and police.[1] Farmers combat the hunger of the community; physicians, disease; lawyers, misapprehension, injustice and crime; clergymen, the ape, bull and tiger in man; and all good citizens are in constant warfare with the undesirable elements of society; but these groups do not proclaim themselves by needless, conspicuous and costly Pharisaic habiliments.

According to the official pamphlet named above the prices of the "hooded gown" for the master's degree range from $35 to $85; those for the doctorate, $10 more. For some classes such an outlay for garments to be worn upon comparatively infrequent occasions might not be excessive. But, until recently, most college professors, excepting such as had independent means or no families, were pleading with reason and commonly in vain for compensation that might enable them to provide for a less productive period of life. Now that the specter of retirement-penury has been exorcised by the bounty of Andrew Carnegie is it any the more becoming in his beneficiaries to indulge in a costly revival of medieval flummery?[2]

[1] It is not denied that occasions might arise when uniforms indicative of ordinated pedagogic authority might prove useful in quelling disorder and averting destruction of property as, *e. g.*, at the recently reported *ante factum* football demonstration in the dining hall of a great university; the writer believes, however, that in all such cases a well-disciplined and fully supported fire department would act more appropriately and effectively.

[2] A somewhat comparable condition confronts former officers of the United States Volunteer Army in respect to membership in the "Military Order of the Loyal Legion." The initiation fee is $35 and the annual dues for residents, $12. Unlike retired officers of the regular army volunteer officers (unless more or less disabled by wounds or disease) receive from the government only a moderate pension proportionate to their age and length of service. Even this is of real help to many. Probably others besides the writer feel that the essential requirements and objects of the "Loyal Legion," viz., a modest badge, clerical service, and aid to the needy, might be provided for at a far less initial and yearly expenditure, and that conformity to the present scale is burdensome for many and unbecoming the beneficiaries of the nation. I resist the temptation to animadvert upon the showy, complex and cumbersome dress uniform and equipment of army officers as incongruous with the ideal of the professional soldier as a component of an efficient fighting machine.

The foregoing considerations are submitted in the hope that reflection upon them may lead some, especially among the younger scientists, to resist the temptation to "follow the fashion." They would better imitate the elder Agassiz; he received many foreign decorations; yet I never saw them displayed or witnessed in his demeanor or dress any feature suggesting a distinction between himself and the average American citizen.

BURT G. WILDER,
Emeritus professor in Cornell University, and formerly surgeon of the Fifty-fifth Regiment of Massachusetts Volunteer Infantry

WASHINGTON, D. C.,
November 25, 1912

THE LATE DR. EDWIN TAUSCH

TO THE EDITOR OF SCIENCE: Permit me to call attention to a sad case of the widow and children of a man eminent in science—a case well worthy of charitable help from those who are able or disposed to give. Dr. Edwin Tausch, a young German, graduate in psychology from one of the German universities, was professor in Ohio University at Athens, and afterwards because of failing health, accepted the chair of psychology and philosophy in Willamette University, Salem, Oregon, but was obliged to give up this work on account of heart troubles, and finally during the past

summer died, leaving a wife and two children almost penniless in Germany. It is almost impossible for Mrs. Tausch to support herself and her children in that country and unless she can do so the children will be placed in an orphanage. It is her wish to find means for herself and her children to return to America where the children were born and where she herself would be able to find work as a teacher. In Germany "hundreds like herself are already waiting for a position wherever there is an opening." Dr. Tausch published a number of valuable papers, notably a sympathetic review of Dr. James's "Pragmatism." A study of the psychology of Tolstoy is still unpublished, as well as an extensive volume on pragmatic philosophy. Should any one feel like granting aid to the widow of this gifted but unfortunate scholar money may be sent through the writer or to Madam Elizabeth Tausch, care Frau von Wissman Warkotsch Kreis, Strehlen, Schlesien, Germany.

DAVID STARR JORDAN
LELAND STANFORD JUNIOR UNIVERSITY

SCIENTIFIC BOOKS

The Humble-Bee, its Life History and How to Domesticate it, with Descriptions of All the British Species of Bombus and Psithyrus. By F. W. L. SLADEN. London, Macmillan & Company, Limited. 1912. Pp. xiii + 283; 6 plates and 33 text figures. $1.50 net.

This account of the life-history of the humble-bee will be more than welcome to every entomologist and student of animal behavior, not only because it is written by an eminent authority on the honey-bee, but because it is one of those rare nature books that are the mature fruit of a life-long interest and occupation. The author is so intimately acquainted with every detail in the daily and seasonal life of the British humble-bees and its parasites, and handles his subject in such a clever and fascinating manner, that one may fail to appreciate the great amount of patient observation and toilsome experimentation on which his statements are based. With true British independence he refrains from annoying and confusing the reader with citations of the large and scattered literature of the subject. Almost the only continental work he cites on the habits of the humble-bee is the classic memoir of Hoffer, "Die Hummeln Steiermarks," published thirty years ago (1882). The more recent work of Wladimir Wagner, "Psychobiologische Untersuchungen an Hummeln mit Bezugnahme auf die Frage der Geselligkeit im Tierreiche," *Zoologica*, Heft 46, I. and II., 1906 and 1907, is not even mentioned, and one familiar with this work may be pardoned if he secretely hopes that Sladen has never seen it, not because it is devoid of considerable merit, but because its spirit gives one reason to suspect that Sladen might have become sophisticated by its perusal. There is, indeed, no better way of appreciating the English author's work than by following it with a perusal of Wagner. Both authors have independently discovered and described a number of important peculiarities in humble-bee life that were unknown to Hoffer, but how different is the view-point from which their observations are made! In Sladen's work the humble-bee is the heroine of the story. She moves before us in all the glory of her regal, velvety attire, with the joyous or apprehensive hum of incessant, arduous labor and self-sacrificing motherhood. In Wagner's account it is Wladimir Wagner who occupies the foreground as the somewhat bumptious scientist who looks at the humble-bee, makes an observation, forthwith settles its connection with some lop-sided hypothesis, incidentally belabors a few contrary-minded, or bestows his approval on a few like-minded students of animal behavior, and then repeats the process. Sladen, on the other hand, writes with charming, sympathetic insight, and utterly unmindful of committing one of the most deadly sins that it is possible for a modern student of animal behavior to commit, pens such sentences as the following, in which the italics are the reviewer's: "The queen's *intelligence* is seen at its best while she is thus *caring* for her brood, and her *devotion* to it, and her *alertness* on the slightest approach of danger, are most interesting to witness. She shows

no *desire* to escape unless she is severely molested and is quite *content* with her brood, *anxiously* incubating it day and night." This is the way Wagner, who is beset with a terrible anxiety lest he commit this deadly sin of "grober Anthropomorphismus," describes the behavior of the same insect: "Eine nicht weniger auffallende Erscheinung ist der Versuch der Hummel, das Nest auszubessern. Erregt durch das eindringende Licht, steigt sie von der Wabe auf den Boden herab und kriecht rückwärts zu derselben zurück, wobei sie die bei solchen Gelegenheiten üblichen Bewegungen des 'Zusammenscharrens' trockener Pflanzenteile ausführt, d. h. nicht nur Bewegungen macht, deren Bedeutung sie nicht versteht, sondern nicht einmal im stande ist, auch nur die geringsten Resultate ihrer Tätigkeit wahrzunehmen, welche sie nur aus dem Grunde ausübt, weil diese Tätigkeit eine Reaktion auf die Gesamtheit der äusseren Reize darstellt." Surely, if we may ask Sladen how he knows that the humble-bee experiences anything akin to the affection and solicitude of the human mother for her offspring, we may also ask Wagner how he knows that such a highly organized insect as the humble-bee is a mere machine and absolutely unable to appreciate the results of any of her activities. Such quotations reveal the difference between Sladen's and Wagner's methods of observation and incidentally between the two schools of animal behavior which they represent. To one the insect is a wonderful and inexhaustible living organism, whose activities can be most satisfactorily described in the language which we employ when speaking of another individual of our own species; to the other the insect is a pure mechanism, whose every movement is easily expounded by the observer, who stands in the foreground and uses the observed object largely as a means of displaying his own analytical and explanatory acumen. The student of animal behavior, who wishes to appreciate the merits and defects of each of these methods, can hardly do better than to read in close sequence Sladen's and Wagner's memoirs on the humble-bee.

Sladen's book begins with a brief introductory chapter on humble-bees in general, their geographical distribution, their relations to flowers and their more important external characters. This is followed by a beautiful account of the life-history of the British species, with excellent figures of their nests, illustrating the behavior of the queen in establishing the colony, and the growth and arrangement of the brood-comb and of the honey- and pollen-pots. The author's interesting and original classification of the British *Bombi* as "pollen-storers" (*B. lapidarius, terrestris, lucorum, soroënsis, pratorum, jonellus, lapponicus* and *cullumanus*) and "pocket-makers," which are subdivided into "pollen-primers" (*B. ruderatus, hortorum, latreiellellus* and *distinguendus*) and "carder-bees" (*B. deshamellus, sylvarum, agrorum, helferanus* and *muscorum*) is described and illustrated in detail. The third chapter, devoted to the "usurper bees" of the genus *Psithyrus*, carries us well beyond the researches of Hoffer and gives us the complete life-history of these extraordinary parasites. As ascertained by Sladen, this life history resembles in the most striking and suggestive manner that of certain parasitic ants of the genera *Polyergus* and *Bothriomyrmex*, since the female *Psithyrus* usurps the position of the *Bombus* queen by killing her and securing adoption by her workers, which then assist the parasite in bringing up her brood.

The fourth chapter takes up the other *Bombus* parasites and enemies. These constitute a very large and motley assemblage of organisms, including the meadow mice, a peculiar wax-moth (*Aphomia sociella*) which devours not only the cells, but also the brood of the humble-bee, a Tachinid fly (*Brachycoma devia*), the highly mimetic *Volucella bombylans*, besides several other Diptera belonging to the genera *Fannia, Phora, Conops*, etc., several Hymenoptera, especially *Mutilla europæa*, certain Braconids and ants, more than 50 species of Coleoptera, among which *Antherophagus nigricornis*, a small beetle that is carried from the flowers, into the nests attached by its mandibles to the proboscis of the bee, is one of the most interesting, several

mites, a singular Nematode worm, *Sphærularia bombi*, which lives in the abdomen of the queen, and a Microsporidian belonging to the genus *Nosema* and allied to the *N. apis* recently shown to be the cause of the "Isle of Wight disease" of the honey-bee. Several of these parasites may simultaneously attack a colony of humble-bees and completely destroy it in a very short time. The reviewer, on August 18, 1909, found under a stone at Zermatt, Switzerland, a small alpine humble-bees' colony which had been utterly wiped out by no less than three of these parasites. The cells and brood had been devoured by a mass of wax-moth larvæ (*Aphomia*) which were nearly ready to pupate. Among these lay a number of puparia of the Tachinid *Brachycoma,* while perched on the top of the nest among four dead and dying humble-bees was a fine female *Mutilla europæa.* It is certainly remarkable that notwithstanding the inroads of all these parasites and prædators and the small size of the colonies compared with those of many other social insects, the humble-bees, nevertheless, manage not only to survive, but to maintain their position among the commonest insects of the north temperate zone. And this dominance of the genus *Bombus* is even more surprising when we stop to consider that its species very easily succumb to excessive moisture, especially in countries like Great Britain.

Chapters V. to VII. of Sladen's work treat of the practical methods of studying the humble-bees, of finding and taking their nests, of the construction of artificial or observation hives, and of attracting to the latter the overwintered queens. In these chapters, which show how Sladen acquired his intimate knowledge of humble-bee behavior, we can also detect the advantages he has secured from his practical study of the honey-bee. By "domestication" he means merely the bringing of the humble-bee into the same relations to man as those obtaining in the case of the honey-bee. In the proper sense of the term, of course, neither of these insects can be domesticated.

The eighth chapter of the work is devoted to the taxonomy of the British humble-bees and is illustrated by five fine colored plates, showing the males and females, and a plate of line-drawings, showing the male genitalia, of the 17 species of *Bombus* and six species of *Psithyrus* known to occur in Great Britain. The work concludes with a short chapter on making a collection of humble-bees, one containing a number of interesting notes and anecdotes and a brief appendix with some additional miscellaneous observations. It is certain that this volume will long remain a classic and an inspiration not only to British students of humble-bees, but to many of our entomologists, whom its perusal should encourage to acquire an equally intimate knowledge of the practically all but unknown habits of the numerous North American *Bombi.*

W. M. WHEELER

The Snakes of South Africa: Their Venom and the Treatment of Snake Bite. By F. W. FITZSIMONS. With 193 figures, mostly original photographs. New edition. Cape Town and Pretoria, T. Mashew Miller; New York, Longmans, Green & Company. Pp. xvi + 547.

This book is a natural history of South African snakes that, while written in a popular way and primarily for South Africans, and mainly devoted to the relations of the poisonous species to man, deserves to be brought to the attention of students of herpetology. The writer attempts to acquaint the residents of South Africa with the general habits of the snakes of their region, and to point out to the general reader, in simple language, the possibilities of being bitten by a poisonous snake, the action of the venom, and the best treatment that the investigators of the nature of snake venom have worked out.

As the principal aim of the book is thus to educate the non-scientific readers in a region where venomous snakes abound, one can not quarrel with the author for devoting considerable space to the poisonous species, even though his only original contributions to this subject are the results of investigations of the toxicity of the South African species. There

is nothing of interest to the student of herpetology in the first two chapters, on the classification, evolution, history, distribution, general habits and identification of species of snakes, and the chapter on snake charmers, Kafir superstitions, etc., and the one on human physiology may also be ignored.

On the other hand, the herpetologist will find much of interest in the accounts of the habits of different species. The writer is evidently a careful field observer, and his descriptions of the feeding and breeding habits of certain forms are a distinct contribution. For example, the description of the feeding habits of the puff adder (p. 225) could hardly be improved. A very notable feature also is the numerous photographs of snakes, both in their natural haunts and in captivity. The series showing a specimen of *Dasypeltis scabra* eating an egg and ejecting the shell, and the photographs of the mole snake, ringhals cobra, and puff adder with newly born young are notable, and there are many others of equal interest. There is also a considerable amount of information on the habitat preferences of various forms that will be useful.

The author is to be commended for the care exercised in guarding against the errors that are so liable to occur in a popular account. The word skin is rather loosely used for the stratum corneum in the account of sloughing (p. 16); snakes do frequently eat dead animals in nature (p. 40); it is doubtful if many naturalists still hold the opinion that the fangs of opisthoglyphs are primarily for holding the prey (p. 139); and the toad is not a reptile (p. 227). It is rather surprising that the writer advocates sucking the wound made by the bite of a venomous snake, since this is dangerous unless one is sure that there are no abrasions about the mouth, and Noguchi asserts that the procedure is quite useless. It may be added that the author's style is rather tautological, there is some irrelevant matter, and a closer grouping of the subject matter would be advantageous.

The reviewer would suggest that an easy key to the South African species would much increase the value of the book. It is doubtful if many persons would take the trouble to dissect out the jaws to identify the species; at any rate it would not be easy to use the author's key, scattered as it is over several chapters.

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General Physics. By W. WATSON, F.R.S. Longmans, Green & Co. 564 pages, with 311 figures and diagrams.

It is a very interesting fact that Professor Watson, who has given to us the comprehensive "Text-book of Physics" with its nine hundred and fifty pages, should find it necessary to arrange another text to meet the needs of "engineering, medical and other students." Not only has he condensed and rearranged his larger work, he has placed the emphasis on different topics and has omitted many. Among these may be noted the discussion of the energetics of a voltaic cell and that of Maxwell's electromagnetic theory. Fifty pages in the older text are given to electrolysis and electric cells where only sixteen are required in the new text. The three hundred pages given to electricity and magnetism in the older text have here been cut in half, notwithstanding the fact that much new matter is added on account of the discussion of radioactivity and wireless telegraphy.

It is rather probable that the newer text will suit the needs of a larger number of instructors in general physics in American colleges than did the older text. For it can be said that the table of contents includes all the main essential principles of physics with a reasonable number of applications to the affairs of every-day life. The presentation is direct, matter of fact, concise, clear. There is no time or space for the spectacular or ornate. The author, being an Englishman, does not give an explanation, right or wrong, of the curving of a base ball, nor of a tennis ball—though had he done so he might have claimed that he was but following the example set by the illustrious Newton. Nor is the mono-rail car discussed. But in America

these omissions are not as serious as they are in England, for here one can probably find them discussed in the Sunday editions of the daily papers!

There are some omissions, however. In the chapter on radiation no mention is made of the sensitive instruments for detecting and measuring radiant energy—the thermoelement, the radiometer, the bolometer. In fact, the discussion of radiation is rather inadequate. In the chapter on the interference of light several pages are given to the discussion of Fresnel's mirrors and biprism, but no mention is made of the interferometer, although the latter is as important theoretically as the former and vastly more important in its numerous applications to exact measurement.

In the chapters devoted to heat, however, admirable illustrations of the application of the principles to modern heat engines are given. In electricity, too, the points of contact of the subject with the world of to-day are shown.

In a book where so much material is presented in so few pages the method of approach is abrupt and the style at times uninteresting. The text will not find favor with those teachers who place emphasis on the inductive aspect of the science nor will it be pleasing to those students who look for entertainment in their reading, but it is a very dependable, clear and fairly complete statement of the principles of physics.

G. F. Hull

Dartmouth College

Essentials of Physics for College Students. A Text-book for Undergraduates and a Lecture Course and Reference Work for Teachers and Other Students of Physics. By Daniel W. Hering. The D. Van Nostrand Co. 353 pages, with 166 illustrations.

The author tells us in the preface that the work is the outgrowth of a course of lectures which he has delivered for several years past to undergraduate students, and that it is intended for that class of students preparing to fill the position of educated men and women who are not specialists in science. As the contents of the book are intended to be presented in "sixty lectures of fifty minutes each" some rather important, perhaps essential, parts of the subject have received a very brief description. On the other hand, liberal space is given to some pseudo-philosophic topics. One notes that the author gives only two pages to the presentation and discussion of the mechanical equivalent of heat and the laws of thermodynamics. The connection between the absorbing and reflecting power of surfaces is given in two lines. But notwithstanding this brevity the author devotes the larger part of the first twelve pages to these captions or questions: Physics, is it or is it not a study of matter, ether and motion? Why study physics? Space, time, matter; Energy "a capability of matter." The best feature in this discussion is found in the definitions and statements quoted from Maxwell's "Matter and Motion."

A couple of pages are given to the discussion of *inertia* in which the author decides that one can no more measure the quantity of matter by its inertia than one can measure the size of a dead elephant by its deadness. This adherence to the notion that *inertia* is a property of matter which can not be represented quantitatively is not in accord with the custom of physicists. The terms *inertia* and *moment of inertia* are used quantitatively in physics. Such authors as Crew and Ames set forth in a very clear manner the mode of measuring the quantity of a bit of matter by its inertia or reluctance to change of linear motion. The author does not deal with the large topic of rotational motion, consequently he makes no reference to *moment of inertia*.

In dealing with the units involved in force and work the author brings in the engineer's system (footnote, p. 32): "If force be measured in pounds then the mass will be in pounds ÷ 32 and work will be in foot-pounds." Had the equation of force been written $F = kma$ instead of $F = ma$ there would have been no necessity for this statement and the confusion it brings to students would have been avoided.

Apart from these criticisms the text is to

be commended for the clearness with which physical principles are stated, and for the numerous workable and practical problems. That part of the text dealing with lenses and with problems concerning the eye is especially to be commended.

One feature of the text which distinguishes it from others is the grouping together of descriptions of demonstration experiments at the end of each chapter. This is a matter of considerable convenience to an instructor and should prove interesting to a student. Another commendable feature is the large number of references to, or quotations from, other texts or original articles.

The author apparently has not attempted to condense as great a number of facts and principles as possible into the text, but has attempted to present in an interesting form what appears to him to be of most importance, and he has succeeded. As a piece of bookmaking the text is excellent.

G. F. HULL

DARTMOUTH COLLEGE

SPECIAL ARTICLES

THE NUTRITIVE VALUE OF THE PROTEINS OF MAIZE[1]

THE state of knowledge at present prevailing concerning the nutritive value of cornmeal when fed to domestic animals is clearly presented in a letter which I recently received from Professor Willard, of the Kansas Agricultural College, who has had a wide experience with practical feeding experiments made on a large scale on domestic animals. He says:

It is a matter of common experience extending over many years, that corn appears to be deficient in some particular in nutritive value. Some have thought to account for this on the basis of low protein content; others have attributed the result to its small percentage of ash; still others have taken into account not only the small percentage of ash, but its unbalanced character, being deficient in calcium and possessing a large percentage of magnesium; still more recently there has appeared the possibility that the defect may find an explanation in limitations in the amino-acid components present in the corn protein.

From this quotation it is evident that further study is needed in respect to the relative nutritive value of the constituents of this seed. Professor Mendel and I have recently obtained preliminary results from feeding maize proteins to white rats under conditions similar to those which I described at our fall meeting last year.

The proteins of maize have not received the attention that their great economic importance demands, for these, the most valuable constituents of this seed, form from eight to ten per cent. of a crop which in this country alone is annually worth one and a half billion dollars. This is the more remarkable as those chemical investigations which have been made show that at least one half of the protein of this seed consists of a type possessing such unique chemical and physical characters as to make it probable that its nutritive properties differ to a marked extent from those of the proteins in other foods of either vegetable or animal origin.

In addition to this protein, known as zein, the maize kernel contains small quantities of globulins, albumins and proteoses and also protein substance insoluble in neutral solvents which can be extracted from this seed only by dilute alkalies. This latter protein has been named maize glutelin. According to such data as are at present available, zein forms about 58 per cent. of the proteins of corn, the globulins, albumins, and proteoses together about 6 per cent., and the remaining 36 per cent. is supposed to be maize glutelin.

The few recorded attempts to determine the nutritive value of maize proteins, in the isolated state, have been made only with zein. The conditions under which these have been conducted have been such as to render the results of uncertain value, although in every instance zein, when supplied as the only protein, proved ineffective for maintaining adult animals or promoting the growth of the young.

Zein presents striking differences in its amino-acid make-up when compared with the other proteins commonly present in foods. The greatest interest has centered about the

[1] Read before the National Academy, November 13, 1912.

entire absence of tryptophane and lysine, for feeding experiments with zein were expected to shed light on the important question of amino-acid synthesis by the animal.

Maize glutelin, in contrast to zein, yields all of the amino-acids commonly found in proteins and in proportions corresponding to those yielded by the majority of animal or vegetable proteins.

The globulins, albumins, and proteoses occur in such small quantities that it has not been possible to obtain them in sufficient amount to determine their amino-acid make-up, or their value in nutrition.

and food intake, broken line, of several rats fed on our protein-free milk diet.[3] During period 2 all of these rats had a diet containing zein as its sole protein and, as you will note, they rapidly declined in weight, although the food intake remained nearly constant, or was even increased, as shown by rats 617 and 647. That this quantity of food was sufficient for maintenance is shown by rats 628 and 659, which regained part of their lost weight on an even smaller quantity of food after the zein had been replaced by gliadin. The increased food intake when zein was replaced by casein, edestin or lactalbumin is largely to be ascribed

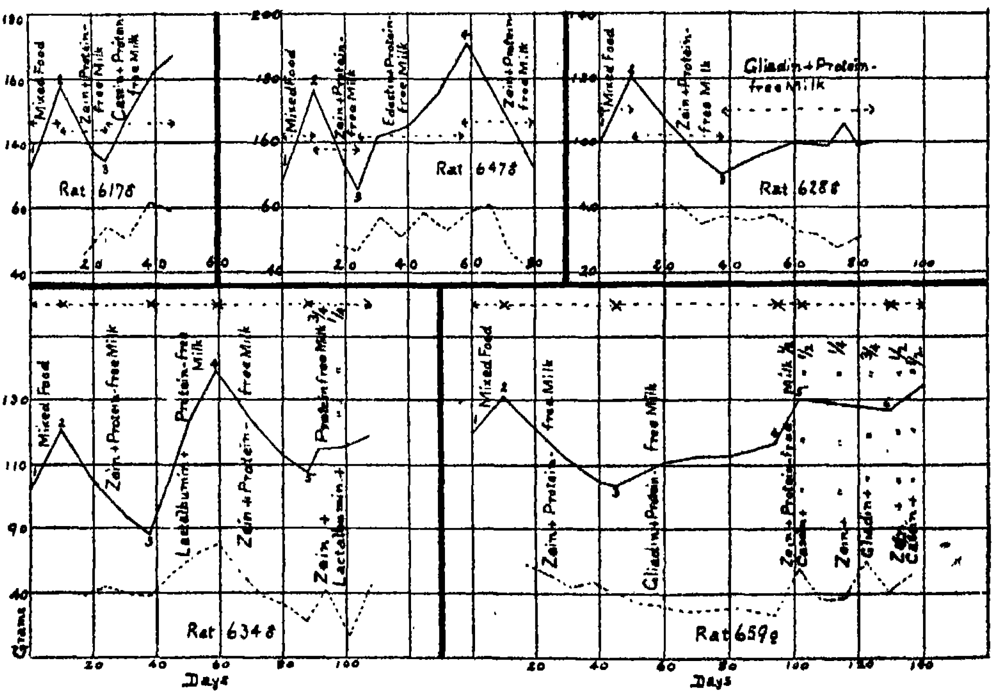

CHART I

Last fall the results of two experiments with mature rats supplied with food containing zein as its sole protein were described. In both cases the animals declined rapidly in weight, although their food intake remained practically constant. These results have since been confirmed by a large number of experiments, some of which are illustrated by the following charts.

Chart I. shows the body weight, solid line, to the rapid gain in weight which took place when this change was made in the ration. It might be thought that a failure to digest and assimilate zein was the cause of the decline on the zein diet, but curves which you will see later show that can not be so, for the addition of a small amount of tryptophane renders the

[3] SCIENCE, N. S., Vol. XXXIV., No. 882, pp. 722–733, November 24, 1911.

zein food efficient for maintenance over a long period.

Our experiments show that there is a very great difference in the food value of different proteins. Thus we have complete nutritive failure with zein, maintenance with gliadin, and restoration of lost weight, or normal growth, with either casein, lactalbumin or edestin. These three latter proteins yield on hydrolysis both tryptophane and lysine, which zein lacks, whereas bliadin, which is incapable of promoting growth, yields tryptophane, but only a very insignificant proportion of lysine. Gliadin resembles zein in the proportion of amino-acids, other than tryptophane, but differs widely from casein, lactalbumin or edestin.

Chart II. shows that when a quantity of tryptophane corresponding to 3 per cent. of the protein is added to the zein food, the rat does not decline in weight, but is maintained without growth, just as if fed with gliadin. The curve for rat 892 likewise shows maintenance without growth. This experiment, which is still in progress, indicates that the failure to grow, shown by rat 593, or by rats fed with gliadin, is not due to a lack of lysine in the protein. The fall in weight shown by these two rats at the beginning of the experiment is probably chiefly due to the less bulky experimental food, and the consequent smaller quantity of feces in the digestive tract.

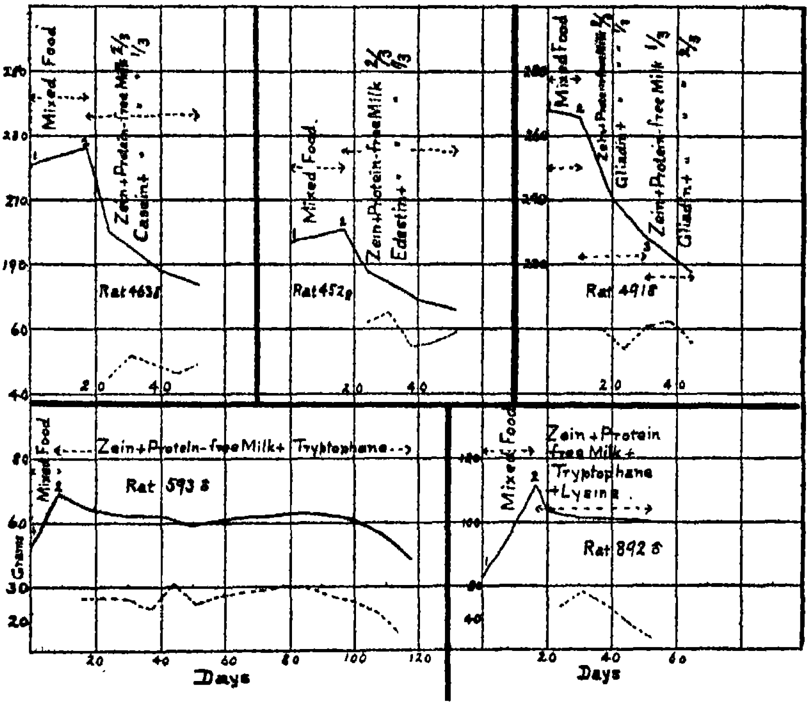

CHART II

Charts I. and II. show that zein is incapable of maintaining rats, unless tryptophane is added to the diet, whereas on the other proteins, all of which yield tryptophane, they recover their lost weight, and grow at a normal rate except on gliadin. This raises the question whether or not the replacement of a part of the zein by other proteins containing tryptophane will render the ration effective in promoting growth. Unfortunately there is no method known whereby the amount of tryptophane in a protein can be even approximately determined. The nearest approach to an estimate of the relative amount is given by a comparison of the intensity of the color shown by the glyoxylic acid reaction. Such a compari-

son indicates that lactalbumin yields much more tryptophane than edestin, and that edestin yields somewhat more than casein or gliadin, which give reactions of about equal intensity.

We have made some preliminary experiments to determine the effect of replacing a part of the zein with other proteins, but these have not been continued long enough to give final conclusions. The three upper curves show that when one third of the zein is replaced by casein, edestin or gliadin the rat rapidly loses weight. The fall is less rapid and less extensive when one third of the zein is replaced by edestin than when it is replaced by casein.

Chart I., rat 634, shows that when one fourth of the zein is replaced by lactalbumin, weight is regained. Unfortunately this experiment was terminated by death from diseased lungs.

Chart III. shows that rat 633 regained its lost weight very rapidly when one half or one quarter of the zein was replaced by lactalbumin. Rat 487 regained its loss more slowly with one half edestin. Rat 644 was maintained by one half gliadin, and declined rapidly and died when changed to a diet containing one half zein and one half gelatin, a protein which like zein lacks tryptophane.

So far as these results go they agree with the relative intensity of the glyoxylic acid reaction for tryptophane.

Chart IV. shows complete recovery of lost weight when one half of the zein was replaced by casein, and rapid decline when the proportion of casein was reduced to one sixth. This decline was at once stopped when tryptophane was added to the food, the proportion of zein and casein remaining the same. The last period of this experiment was unsatisfactory as the rat soon after died with diseased lungs and kidneys. If disease had not intervened it is not improbable that the lost weight would have been fully regained in period 4.

Chart V. shows a rapid loss of weight when zein formed the sole protein of the diet, and complete recovery when one half of the zein was replaced by casein. After being again reduced on the zein diet, a partial recovery was made when one half of the zein was replaced by edestin, and a nearly complete recovery, when all was replaced by edestin.

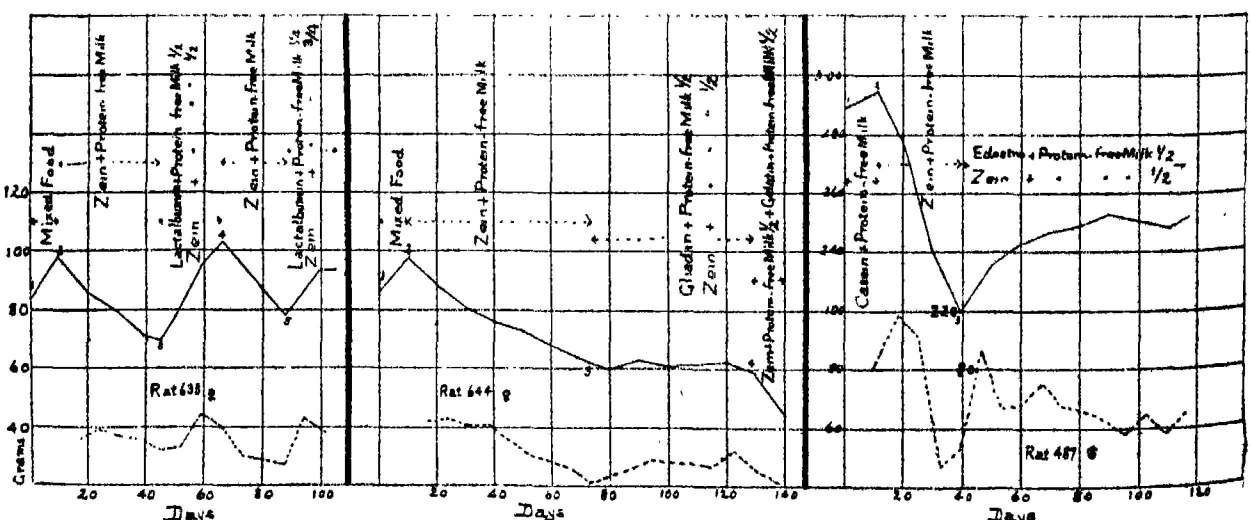

CHART III

It is difficult to understand why diets containing two thirds zein and one third casein or edestin are so inferior to those containing one half of either of these proteins. It may be that experiments now in progress will not confirm these preliminary results, but it is also possible that we shall find that a certain min-

imal quantity of tryptophane is essential for life, and that this is not supplied by these smaller proportions of casein or edestin.

Thus far the experiments I have described have been concerned with zein, which is only one of the proteins of maize.

formed the sole protein. On this diet the rat quadrupled its weight in 70 days, thus exceeding somewhat the average normal rate of growth of rats on natural mixed food. Rat 596 grew more slowly on a diet containing equal parts of zein and maize glutelin.

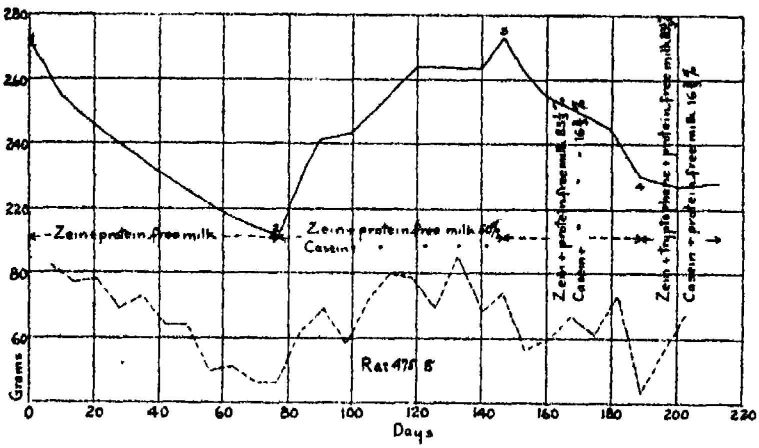

CHART IV

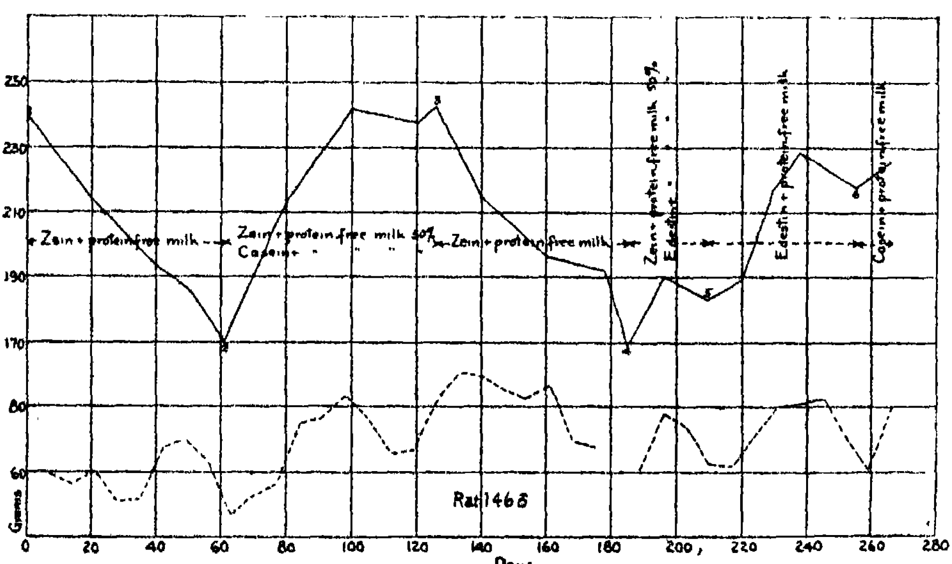

CHART V

Chart VI. shows that corn contains a protein which is capable of promoting normal growth. During period 2, rat 567 was fed with a diet containing the same non-protein constituents as those used in the preceding experiments, but in this food maize glutelin

Chart VII. shows the result of feeding rats with corn gluten. This substance is a product obtained in the manufacture of corn starch, and consists chiefly of zein and maize glutelin, which are separated from the corn by purely mechanical operations. With this

material we have an opportunity to study the nutritive value of the proteins before they have been subjected to the chemical operations incident to their isolation and purification. These curves show that the mixture of proteins in the corn gluten is capable of maintaining mals. It is interesting to note that the weight lost by these animals was much more quickly regained when one half of the corn gluten was replaced by lactalbumin than by edestin, results which agree with those obtained by adding these proteins to the zein diets.

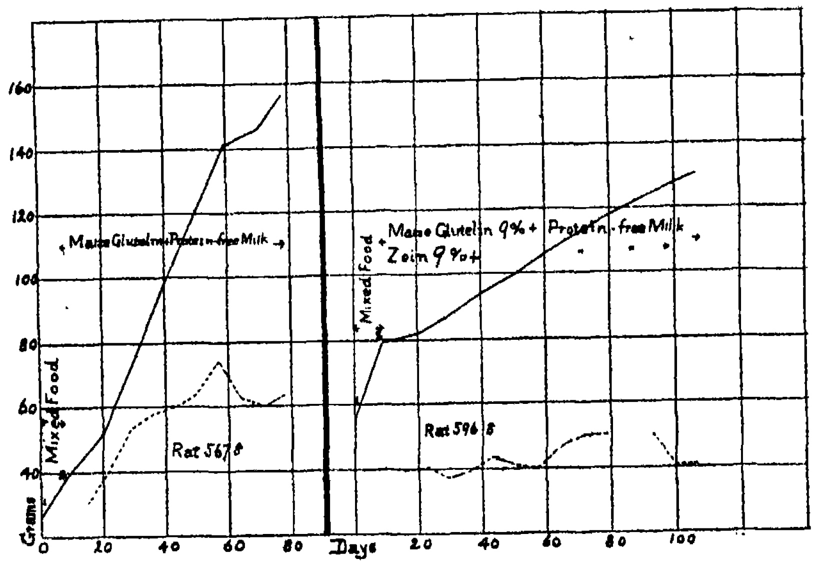

CHART VI

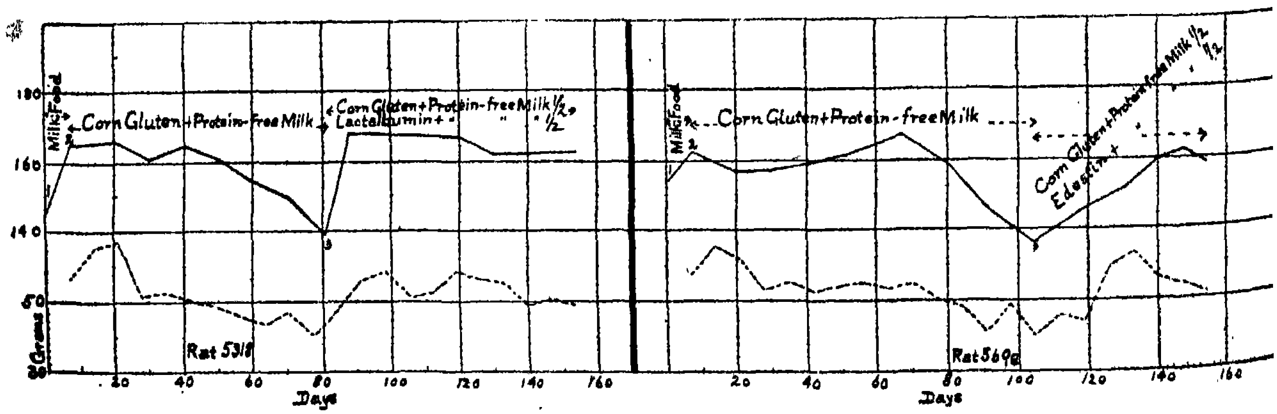

CHART VII

rats for some time. Unfortunately at the time these experiments were started our supply of stock rats was so low we were obliged to use rats which had been previously subjected to long-continued experimental feeding. Doubtless better results will be obtained when we repeat these experiments with fresh ani-

The results here presented leave no doubt that the deficiency observed in the practical feeding of cornmeal is explained largely, if not wholly, by the unique chemical constitution of zein which forms such a large part of its proteins.

Many more experiments must be made be-

fore the numerous questions raised by our feeding trials can be regarded as settled, and attention must finally be given to the relative food value of mixtures of various food stuffs with corn meal, so that we may know as definitely as possible the most economical combinations to employ in maintaining mature animals and in raising the young. Such experiments must be conducted on a large scale and with a variety of domestic animals. In carrying these out the results obtained by the method I have just described when combined with the experience gained in feeding animals for market will doubtless lead to a lower cost of meat production, and at the same time give us information which will contribute to a clearer understanding of some of the obscure problems of the chemical physiology of nutrition.

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DISCOVERY OF BIVALVE CRUSTACEA IN THE COAL MEASURES NEAR PAWTUCKET, R. I.

WHILE collecting fossils for the Museum of Comparative Zoology, Cambridge, from the Carboniferous graphitic slates of Central Falls, Rhode Island, last June, the writer discovered in a half inch layer at two localities one hundred yards apart about two dozen, more or less well preserved impressions of carapaces of bivalve crustacea of the genera *Leaia* and *Estheria,* in the same layer with numerous plant impressions, chiefly leaves of Cordaites and Calamites. No record of their having been previously discovered in the Narragansett Basin Coal Measures was found by the writer, and no specimens of any bivalve crustacea occur in the collection of Coal Measure material from the basin, at Brown University or at Harvard.

The faunal remains from the Narragansett Basin Coal Measures are comparatively meager, and consist largely of tracks which are in many cases of doubtful determination. Previous to the year 1900, fourteen species of insects and one arachnid were identified by Scudder,[1] and the tracks of a probable annelid and of a mollusc or worm were described.[2] In 1900 A. S. Packard[3] described some probable worm tracks, and those of a possible crustacean which were found in some red shale boulders at South Attleboro. He described and named another track found in a pebble of arenaceous shale in a kame in North Providence, and three fragments of a possible macrurous crustacean from the black shales of Valley Falls, R. I., and noted a locality near East Attleboro, shown to him by Professor J. B. Woodworth, where sand-filled worm borings occur in the red and green shales. He also described and identified several casts of valves of a fresh-water mollusc *Anthracomya arenacea* (Dawson) Hind, from a boulder of fine black shale at Valley Falls, and one specimen from a shale bed north of Silver Spring, East Providence.

Numerous supposed amphibian tracks have been found by Professor J. B. Woodworth near Plainville, Mass., and one species, *Batrachichnus plainvillensis,* has been described[4] and named by him. Since then he and the writer have found many types of tracks from several localities near Plainville, and these will probably be described in detail soon. Two or three tracks of probable amphibia were found by Professor Woodworth and the writer last June at Valley Falls and Central Falls, R. I., which is very much south of the localities where they have been previously noted.

From this brief summary of the occurrence of the fossil fauna, it will be seen that only a part of the specimens have been found *in situ,* and the majority of these are tracks. The discovery of these bivalve crustacea in place is therefore of considerable importance.

The impressions of the valves of *Leaia* and *Estheria* occur in a grayish black, somewhat graphitic slate bed along the south bank of the Blackstone River in Central Falls, R. I. The beds strike N. 70°–80° E. about parallel with the river at this place, and dip 70° N.

[1] Bull. U. S. Geol. Survey, No. 101, 1893.

[2] *Proc. Bost. Soc. Nat. Hist.,* XXIV., 1889, pp. 209–216, and *Amer. Jour. Sci.,* 3d Ser., XXXVII., 1889, p. 411.

[3] *Amer. Acad. Arts and Sci. Proc.,* Vol. XXXV., 1900, pp. 399–405.

[4] *Geol. Soc. Am. Bull.,* Vol. IX., 1900, pp. 449–454.

The section consists of alternating slate and gray sandstone layers, of a few feet thickness. The slate usually has numerous fossil plant impressions in it, but the sandstone here is barren of recognizable organic remains.

The specimens of the genus *Leaia* Jones, are in general well preserved and show the surface markings distinctly (see Fig. 1).

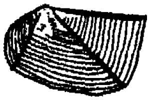

Fig. 1. ×2.

Fig. 2. ×2.

They correspond closely with the description and figures of *Leaia tricarinata* Meek and Worthen,[5] of the Illinois and Indiana Coal Measures. The size of an average specimen from Rhode Island is: length, 8.5 mm.; height, 5 mm. The presence of a well-marked third carina along the dorsal margin and the twelve to sixteen slender concentric ridges, as well as the agreement in size, make it seem safe to call the Rhode Island specimens *Leaia tricarinata.*

Several specimens of the genus *Estheria* Ruppel occur in the same layer with *Leaia* (see Fig. 2). They vary slightly in size and proportions, but all show the generic characters well. The surface markings are not as distinct as in the specimens of *L. tricarinata*, but most of the *Estheria* specimens show from nine to thirteen faint concentric striæ. The size of an average specimen from Rhode Island is: length, 7 mm.; height, 5 mm. The specimens are not sufficiently well preserved to permit of a specific determination.

In the Conemaugh Series of the Carboniferous of Pennsylvania, Dr. P. E. Raymond[6] has noted the presence of *Estheria* and *Leaia tricarinata*, with plant remains, in a red and gray shale layer occurring just below the Ames limestone, which is midway in the Conemaugh Series. Fossils of the two genera occur in several horizons of the Coal Measures. In Illinois *L. tricarinata* ranges from the lower part of the Lower True Coal Measures, to high up in the Upper Coal Measures, therefore neither genus is a good horizon marker. If we regard the *Estheria, L. tricarinata* horizon of the Conemaugh Series as of the same age as that at Central Falls, R. I., we should then be calling this horizon of the Narragansett Basin Series the equivalent of the middle of the Lower Barren Measures of Middle Pennsylvanian age.

WINTHROP P. HAYNES

CAMBRIDGE, MASS.,
October, 1912

[5] *Geol. Surv. Ill.*, Vol. 3, pp. 541–543.

[6] *Ann. Carnegie Mus.*, Vol. V., No. 2 and 3, 1909, p. 173.

THE ELECTROMOTIVE FORCE PRODUCED BY THE ACCELERATION OF CONDUCTORS

THE possibility that electromotive forces may be produced by the mechanical acceleration of electric conductors was first thoroughly considered by Maxwell,[1] and the actual presence of such electromotive forces in *electrolytic* conductors was shown by Colley[2] in 1882.

The desirability of obtaining similar electromotive forces in accelerated *metallic* conductors has long been recognized by the writer. At a meeting of the Harvard and Massachusetts Institute of Technology Physical Chemical Society, held at the Harvard Union in the spring of 1906, he stated that a potential difference was to be expected between the front and rear ends of a metallic conductor which is suddenly stopped, since there will be a tendency for the electrons to continue in motion. Since that time he has often spoken to his colleagues, both privately and at informal scientific meetings, of the desirability of making measurements of this kind in order to obtain information as to the mass of the carrier in metals, and in particular has described as a possible form of apparatus a coil of wire oscillating about its own axis with some form of commutator to permit the detection with an ordinary galvanometer of the alternating current which would be generated.

During the past year at the University of Cincinnati, with the help of his assistant, Mr. Earl W. Osgerby, the writer has carried out

[1] Maxwell, "Treatise on Electricity and Magnetism," 3d edition (1892), Vol. II., 211 *et seq.*

[2] Colley, *Wied. Ann.*, 17, p. 55, 1882.

an elaborate series of measurements on the electromotive forces produced by the acceleration of electrolytes, varying the nature of the solutions used, the magnitude of the acceleration, and the distance between the front and rear electrodes, and is now preparing for publication a description of the work. The experiments were performed, however, primarily as a preliminary to similar work with metals in order to test the quantitative theory as to the magnitude of the effect which would be much larger in electrolytes than in metals, and in order to determine the most suitable form of apparatus for the work. Mr. Osgerby and the writer did, however, carry out some experiments with metallic conductors, but at the time were unable to detect any effect, as further modification of the apparatus is necessary before it will be sensitive enough for metals.

In a recent number of SCIENCE (November 1, 1912) the writer was surprised to observe that Professor Daniel E. Comstock, of the Massachusetts Institute of Technology, has not only apparently attempted to reserve this field of experimental investigation, but to put forward as a new discovery the probability that such electromotive forces would be produced by the acceleration of metallic conductors. The possibility of such electromotive forces has certainly been recognized since the time of Maxwell. In *electrolytic* conductors their actual presence has been shown by the experiments of Colley, and the similar electromotive forces which arise from the action of centrifugal force on electrolytic conductors were demonstrated by Des Coudres[3] and have been thoroughly investigated by the present writer.[4] In another, to obtain effects dependent on the *metallic conductors* Maxwell,[5] Lodge,[6] and Nichols[7] have all attempted, by one method or another, to obtain effects dependent on the "mechanical momentum" accompanying the passage of electricity, but have failed, owing to the lack of sensitiveness of their apparatus. That the conception of "free electrons" necessarily includes the production of an electromotive force in accelerated metals is certainly the common knowledge of physicists who are familiar with the work of the above investigators.

The writer has no desire to reserve a field which is the property of all physicists, but at the present time wishes to report that his experiments are sufficient to show, as would be expected, that the electromotive force produced in accelerated metals is certainly much smaller than that produced in accelerated electrolytes, and to state that the apparatus is now being improved with the hope of detecting the effect in metals.

RICHARD C. TOLMAN

UNIVERSITY OF CALIFORNIA,
November 9, 1912

[3] Des Coudres, *Wied. Ann.*, 49, p. 284, 1893; *ibid.*, 57, p. 232, 1896.

[4] Tolman, *Proc. Amer. Acad.*, 46, p. 109, 1910; *J. Amer. Chem. Soc.*, 33, p. 121, 1911.

[5] Maxwell, loc. cit.

[6] Lodge, "Modern Views of Electricity," 3d edition (1907), p. 89.

[7] Nichols, *Physik. Z.*, 7, p. 640, 1906.

THE AMERICAN SOCIETY FOR PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS

THE fourth annual meeting of the society was held in Cleveland on December 30 and 31. There were two executive and three scientific sessions.

The most important outcome of the Cleveland meeting, as far as the Pharmacological, Physiological and Biochemical Societies are concerned, was the formation of a federation designed to knit these societies more closely together, while yet jealously preserving the individuality of each component. The meeting of delegates with full power to act from each of the three societies, took place during the last informal dinner and smoker at the Colonial Hotel on December 31. The delegates from the Physiological Society were Drs. Meltzer, Lee and Cannon; from the Biochemical Society, Drs. Lusk and Wells; from the Pharmacological Society, Drs. Sollmann, Loevenhart and Auer.

Dr. Meltzer was elected temporary chairman and Dr. Cannon temporary secretary. The outcome of the proceedings of this conference committee will be best shown by a transcript of its minutes:

"The following motions were voted unanimously:

"That a federation of the three societies be hereby established.

"That the presidents and the secretaries of the constituent societies form the executive committee of the federation.

"That the chairmanship of the executive committee be held in turn by the presidents of the constituent societies who shall succeed one another annually in the order of seniority of the societies (physiological, biochemical and pharmacological).

"That the secretary of the executive committee shall be secretary of the society whose president is chairman.

"That the secretaries of the three societies shall consult in preparing the programs of the annual meeting, and that, as far as practicable, and with the author's consent, papers be so distributed as to be read to the society in which they properly belong.

"That the programs of the three societies be published by the secretary of the federation under one cover and that the expense of publication be shared *pro rata* by the societies according to the number of members.

"That the official title of the new organization be 'The Federation of American Societies for Experimental Biology' (comprising the American Physiological Society, the American Society of Biological Chemists, and the American Society for Pharmacology and Experimental Therapeutics).

"That a common meeting place of the federation with the Anatomists, Zoologists and Naturalists is desirable but not mandatory.

"That in the name of the federation, the International Physiological Congress be invited to meet in the United States in 1916.

"That the present conference committee delegate all its powers to the executive committee of the federation.

"The meeting then adjourned."

The first meeting of the new federation will be held next December in Philadelphia.

The scientific program was as follows:

FIRST SESSION

Monday, December 30, 9:00 to 12:00 M.

Wm. Salant: "The Influence of Temperature on the Toxicity of Caffein." Read by title.

Wm. Salant: "Further Observation on the Influence of Caffein on the Circulation." Read by title.

S. P. Beebe and Eleanor Van Alstyne: "The Effect of High Protein Diet on the Growth of Transplantable Tumors of the White Rat."

Lafayette B. Mendel and R. L. Kahn: "The Physiological Action of some Methyl Purines."

J. A. Eyster and W. J. Meek: "The Action of Certain Drugs on the Electrocardiogram."

Paul J. Hanzlik (by invitation): "The Intestinal Absorption of Alcohol."

Paul J. Hanzlik (by invitation): "The 'Toxic Dose' of Salicylates according to Clinical Statistics."

W. H. Brown and A. S. Loevenhart: "The Effect of Hematin upon the Circulation and Respiration."

Wm. De B. MacNider: "The Effect of Anesthetics on the Output of Urine in Uranium Nephritis."

George B. Roth: "The Physiological Assay of Aconitin."

SECOND SESSION

Monday, December 30, 2:00 P.M.

L. G. Rowntree and R. Fitz: "Renal Function in Experimental Passive Congestion."

R. Fitz and L. G. Rowntree: "The Effect of Temporary Occlusion of Renal Circulation on Renal Function."

Wm. W. Ford: "Observations on Three Poisonous Fungi not Previously Described."

J. D. Pilcher: "The Protective Action of Lipoids against Hemolysis."

Henry G. Barbour (by invitation): "The Action of Histamin upon Surviving Arteries."

George W. Crile and J. B. Austin: "Nitrous Oxide Sleep compared with Normal Sleep—Brain Cell Studies."

Wm. T. Porter and J. H. Pratt: "The Action of Diphtheria Toxin on the Vasomotor Center."

Hideyo Noguchi and J. Bronfenbrenner: "The Effects of certain Disinfectants and Therapeutic Preparations upon the Cultivated Spirochætes." Read by title.

Frank M. Surface (by invitation): "The Effect of Surplus Cow Serum on Complement Fixation with Infectious Abortion."

I. Adler and C. L. Alsberg: "Studies upon the Long-continued Administration of Adrenalin and Nicotin." Read by title.

C. L. Alsberg: "The Hemolytic Power of Various Plants." Read by title.

THIRD SESSION

Tuesday, December 31, 9:00 to 12:00 M.

Yandell Henderson: "Demonstration of a Carbonator for Quantitative Carbon-dioxide Therapy." Read by title.

Paul Lewis: "Further Observations on the Relations of Vital Stains to the Tubercle."

T. S. Githens and S. J. Meltzer: "On the Course of the Toxic Effects of Ether and Chloroform under Intratracheal Insufflation."

T. S. Githens: "On the Influence of Decerebration upon Morphin Tetanus in Frogs."

I. S. Kleiner (by invitation): "On the Effect of Sodium Bicarbonate and Sodium Chloride upon the Convulsions produced by Heroin and Strychnin."

J. Auer and S. J. Meltzer: "The Influence of Pituitrin upon the Depressor Action of the Vagus Nerve in Cats."

B. T. Terry: "The Influence of Heat upon the Toxicity for Trypanosomes of Blood containing Transformed Atoxyl."

B. T. Terry: "Variations in the Toxicity of Transformed Atoxyl for Trypanosomes caused by Altering the Number of Organisms."

EXECUTIVE SESSIONS

The following officers were elected for the year 1913:

President—Torald Sollmann.

Secretary—John Auer.

Treasurer—A. S. Loevenhart.

New Members of the Council—J. J. Abel, Wm. de B. MacNider.

Membership Committee—C. W. Edmunds was reelected to serve three years, and the place made vacant by Dr. Sollmann's election to the presidency was filled by the election of Reid Hunt.

New Members—Among the candidates for membership investigated by the membership committee, the following were favorably reported to the council, recommended for election, and elected by the society: Henry Gray Barbour, Yale Medical School; Clyde Brooks, University of Pittsburgh; Cary Eggleston, Cornell Medical School; P. J. Hanzlik, Western Reserve Medical School; D. E. Jackson, Washington University; I. S. Kleiner, Rockefeller Institute; Oscar H. Plant, University of Pennsylvania; A. H. Ryan, University of Pittsburgh; Frank P. Underhill, Yale Medical School.

At the last business meeting the Pharmacological Society passed a vote of thanks to the Western Reserve University for the hospitality extended and to the local committee, Drs. Macleod, Sollmann and Pearce, for its thorough arrangement of all the details which made the Cleveland meeting so pleasant.

J. AUER,
Secretary

THE TENNESSEE ACADEMY OF SCIENCE

THE second session of the first annual meeting of the Tennessee Academy of Science was held at Carnegie Library Hall, University of Tennessee, Knoxville, Tennessee, on November 29–30, 1912.

The following papers were given:

NOVEMBER 29: MORNING SESSION, 10 A.M.

"The Taste Sense in Frogs," Alice N. Porter.

"Hydrogen Peroxide as a Bleaching Agent for Entire Insects," E. C. Cotton.

"Relation of the State to its Water Power Resources," J. A. Switzer.

"The Recent Disturbance in the Northern Equatorial Belt of Jupiter" (read by Professor Porter), Latimer J. Wilson.

AFTERNOON SESSION, 2 P.M.

"The Effects of a Soy Bean Crop on a Following Cereal," Maurice Mulvania.

"The Fourth Dimension," Samuel M. Barton.

"The Occurrence of Aerial Roots on the Virginia Creeper," Samuel M. Bain.

"Micro-color Photography," Samuel M. Bain.

EVENING SESSION, 7:30 P.M.

Address by the retiring president, "Science and Progress in the South."

"The Mastodon and the Glacial Age" (illustrated), W. E. Myers.

Reception to visiting members by the faculty of the University of Tennessee.

NOVEMBER 30, 9:00 P.M.

"Defraction Phenomena Due to the Dimensions of the Source of Light," Brown Ayers.

"Studies in Feeding Habits of *Amœba*," Asa A. Schaeffer.

"The Slates of Georgia," T. Poole Maynard.

"The Importance of the Study of Meteorology in its relation to Agriculture," J. F. Voohees.

"The Breaking of the Nashville Reservoir, November 5, 1912" (illustrated), Wilbur A. Nelson.

"Types of Iron Ore Deposits in East Tennessee," C. H. Gordon.

The following officers were elected for the ensuing year:

President—Watson Selvage, University of the South, Sewanee.

Vice-president—G. A. Dyer, Vanderbilt University, Nashville.

Secretary—Wilbur A. Nelson, Tennessee Geological Survey, Nashville.

Treasurer—Samuel M. Barton, University of the South, Sewanee.

Editor—R. M. Ogden, University of Tennessee, Knoxville.

The following resolutions were passed on the conservation of Tennessee's water power and exhibits at the national expositions:

"WHEREAS, it is becoming increasingly evident that the water power of our state is becoming appropriated to corporate use and alienated, perhaps forever, from the control of the commonwealth, to the great detriment of this and future generations, we, the Tennessee Academy of Science, respectfully recommend to his excellency, the governor, and to the legislature of the state of Tennessee, the immediate passage of a law authorizing the governor to appoint a conservation commission which shall have power (1) to grant, under such restrictions as are hereinafter suggested, renewable franchises for a limited term, to all corporations desiring to make use of said water power; (2) to secure a permanent water supply, provide for the cooperation of the state in forestry conservation, and the eventual creation of a state forest reserve; (3) to prevent the diversion of the electric power derived from the natural waters of Tennessee to the enrichment of other states, and to encourage its utilization within our own borders, and to that end (4) to cooperate with the boards of trade and other civic bodies to secure the location of industrial plants in all localities where power is cheap and abundant, and (5) to assure a more permanent and lasting supply of cheap power throughout this state in all parts thereof, whether blessed with water power or not, by the prevention of waste in mining and use of coal.

"We further recommend that the commission be instructed to investigate the feasibility of a statewide system of power conservation, development and transmission, whereby every section of the state may enjoy an equitable share of the benefit thereof; and that the commission report its findings to the next session of the legislature.

"We suggest further the appointment on said commission of a practical expert in each of the following departments of activity: hydro-electric engineering, forestry, mining and scientific business management.

"To these ends we recommend the enactment of legislation similar to that already in force in the states of New York and California, providing for the conservation of their natural resources."

"In view of the three great expositions which are to be held in the near future, viz., the National Conservation Exposition, Knoxville, Tenn., 1913, the National Exposition, San Diego, Cal., 1914, and the Panama Canal Exposition, San Francisco, 1915, the Tennessee Academy of Science, at its annual convention in Knoxville assembled, urges that the present session of the legislature should take immediate action to provide for an exhibit that shall properly and adequately set forth the resources of the state, especially in her water powers, her agricultural opportunities, her forests, her mineral wealth and her manufacturing advantages.

"It is suggested that an exhibit that could be used successively in the different expositions above named would advertise the state widely, without a proportionate cost, and would prove to be of extreme material value to the state."

Members from all sections of the state were present at this, the first annual meeting of the academy.

WILBUR A. NELSON,
Secretary

CAPITOL ANNEX,
NASHVILLE, TENN.

THE NEW YORK ACADEMY OF SCIENCES

THE academy and its affiliated societies held their annual dinner, Monday evening, December 16, at the Hotel Endicott. After the dinner, the annual meeting of the academy was held, at the conclusion of which Mr. Emerson McMillin gave his address as retiring president, in which, after reviewing the present condition of the academy as derived from conference with a large number of the men who have long been active in carrying on its various lines of work, he made several recommendations regarding the plans which might be adopted for enlarging the usefulness and interest of the organization and its meetings. The address will be printed in full in the concluding portion of Vol. 22 of the *Annals*. At the close of President McMillin's address, Mr. V. Stefánsson gave a most interesting summary account of the expedition which he and Dr. R. M. Anderson made along the arctic coast of western North America, from Point Barrow to Coronation Gulf, during the years 1908–12 inclusive. At the close of his lecture, Mr. Stefánsson outlined the plans of the second expedition which he is now organizing for geographical and ethnological work on Victoria, Banks and Prince Patricks Islands in the years

1913–16 inclusive, and indicated the manner in which his expedition and the Crocker Land Expedition will supplement each other's work.

The report of the corresponding secretary showed that the academy had lost by death, during the past year, the following honorary members: Sir George H. Darwin, elected 1899; Sir Joseph D. Hooker, elected 1907; M. Jules Poincaré, elected 1900; Geh. Rath Professor Ferdinand Zirkel, elected 1904.

At the meeting five honorary members were elected, namely: Professor Frank D. Adams, geologist, McGill University; Dr. George E. Hale, astronomer, Mt. Wilson, California; Professor Iliya Metchnikof, biologist and bacteriologist, Pasteur Institute, Paris; Sir John Murray, geographer and oceanographer, Edinburgh; Professor Sho Watasé, zoologist, Imperial University of Tokyo.

According to the report of the recording secretary, the academy held 8 business meetings and 26 sectional meetings during the year ending November 20, 1912, at which 65 stated papers were presented. Four public lectures were given at the American Museum of Natural History, to the members of the academy and its affiliated societies and their friends. The academy now has on its rolls 468 active members, including 22 associate members, 86 fellows, 90 life members and 11 patrons. There are in addition to this number, 20 non-resident members on the rolls. Announcement was made with regret of the loss by death of the following members: Messrs. John Jacob Astor, George Borup, Charles F. Cox, Morris Loeb, William Pennington, Edward Russ, John B. Smith, Isidor Strauss, James Terry and John Weir.

The treasurer's report showed receipts of \$7,648.17 and expenditures of \$6,092.66 during the fiscal year, including an investment of \$975, leaving a cash balance on hand November 30 of \$1,555.51.

The librarian reported that the library of the academy had received, through exchange and donation, 313 volumes and 1,670 numbers. Much of the effort made to complete imperfect files has been successful. The library has been open for the consultation of books every week-day from 9:30 A.M. to 5 P.M., and the use of the academy's books has increased noticeably.

The editor's report stated that pages 177–263 of Vol. XX. and pages 1–160 of Vol. XXI. had been distributed, and that pages 161–337 of the latter volume were now ready for distribution.

The annual election resulted in the choice of the following officers for the year 1913:

President—Emerson McMillin.

Vice-presidents—J. Edmund Woodman, W. D. Matthew, Charles Lane Poor, W. P. Montague.

Corresponding Secretary—Henry E. Crampton.

Recording Secretary—Edmund Otis Hovey.

Treasurer—Henry L. Doherty.

Librarian—Ralph W. Tower.

Editor—Edmund Otis Hovey.

Councilors (to serve 2 years)—Frederic A. Lucas and R. S. Woodworth.

Members of the Finance Committee—Emerson McMillin, Frederic S. Lee and George F. Kunz.

E. O. HOVEY,
Recording Secretary

SOCIETIES AND ACADEMIES

THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

THE thirteenth regular meeting of the society was held at the residence of Dr. Pfender, January 7, 1913, Dr. Pfender acting as host and Dr. Stiles as chairman.

The following were elected as corresponding members: American—C. C. Bass, Samuel T. Darling, W. B. Herms, George R. LaRue, Theobald Smith and Richard P. Strong; foreign—E. Brumpt, J. B. Cleland, Bruno Galli-Valerio, L. Gedoelst, B. Grassi, A. Henry, J. Ch. Huber, C. Janicki, T. H. Johnston, E. Loennberg, A. Mrázek, Wm. Nicoll, S. von Ratz and K. Wollfhuegel.

Mr. Hall presented the following note:

A Spurious Parasite Reported as Trichinella.

In 1905 and 1908 Staeubli published his method of examining blood for blood parasites. The method consists in adding 3 per cent. acetic acid to fresh blood in order to dissolve the erythrocytes and centrifuging to bring down the blood parasites. In his paper in 1908 he states that it will probably be possible to diagnose trichinosis in suspected human cases by examining blood from a finger or ear puncture instead of resorting to muscle excision.

Since then 3 cases of the finding of *Trichinella* by the use of Staeubli's method in human cases have been reported in the *Archives of Internal Medicine*. Herrick and Janeway (1909) reported a case from New York City in which *Trichinella* was recovered on two occasions in blood from the arm veins. Their specimens were passed on by Drs. Flexner and Oertel also, and judging from this and the photomicrograph they give, their findings should be accepted. Mercur and Barach

(1910) reported a second case from Pittsburgh. They state that the embryos correspond exactly to the one shown in Herrick and Janeway's illustration and their photomicrograph of a parasite from a gastrocnemius excision in the same patient is certainly one of *Trichinella*. Cross (1910) reported a third case from Minneapolis, in which the embryos are said to have been found in one cubic centimeter of blood from ear puncture. He gives a photomicrograph of one and states that two others "were not quite so clearly marked."

An examination of Cross's photomicrograph shows a straight body of homogeneous structure and quite devoid of internal granular or cellular bodies. Along the sides are two dark lines indicative of a high light refraction. This is probably a plant hair or some such object. The trash also shown in the photo indicates that Cross was not successful in guarding against contamination, as advised by Staeubli, and the presence of plant hairs or similar objects under such conditions is what would be expected. The ratio of the length to the width of the object, which ought not to be greater than 26: 1 for a *Trichinella* embryo in the blood, is about 36: 1. These facts, taken in connection with Cross's statement that he found two other specimens which were not quite so clearly marked, indicate that Cross was dealing with plant hairs or some similar foreign bodies simulating *Trichinella*, and the case should not be retained as a case of *Trichinella* discovered in the circulating blood. The only clinical symptoms given—facial edema and a 44 per cent. eosinophilia—leave the case open as far as the existence of a trichinosis is concerned.

Dr. Ransom presented the following note:

The Origin of some High Percentages of Cysticercosis in Cattle.

In a note read before this society and published in SCIENCE for April 19, 1912, the writer called attention to some cases of infestation of cattle with *Cysticercus bovis* in which three lots of 251, 70 and 201 head had 25, 41 and 39 head, respectively, infested. These cattle were all from the same locality and an examination of the surroundings showed the following conditions, according to the report of Dr. Eagle, of the U. S. Bureau of Animal Industry: (1) the intake of the water supply for the cattle troughs was in a small river 75 yards below the outlet of the sewer from the city where the cattle were being fed; (2) in the cattle yard was a stagnant pool which was the only water the cattle had to drink when the regular supply was frozen, as it frequently was during the winter, and this pool received the drainage from an area containing the privies of the establishment where the feeding was done and from part of the city where soil pollution existed; (3) the cattle were fed cotton seed hulls which were more or less contaminated with human feces, as it was a common practise of the employees of the establishment to defecate in the buildings where the hulls were stored. Such surroundings give almost perfect conditions for infestation with *Cysticercus bovis*.

Dr. Stiles presented the following notes on technique and treatment:

In centrifuging feces in fecal examinations, the State Board of Health of Kentucky, instead of using a centrifuge tube, is now using ordinary glass tubing, smoothed off at the ends after cutting to the length of the centrifuge tube. These tubes are corked at both ends. After centrifuging in the tube holder, the upper fluid is poured off and the sediment is taken out at the bottom by the removal of the cork, the cork being used in smearing the feces on the slide. Dr. Stiles has found this a very satisfactory proceeding, but states that on several occasions he has found eggs by the ordinary smear method in cases which were negative by the centrifuge method.

Judging from several cases in which it has been tried, the use of flowers of sulphur seems to be of promise in the treatment of infections with *Strongyloides stercoralis*. It also appears to be successful in the one case of flagellate diarrhea in which it has been used. This was a case with an excessive infestation, the stools being almost pure cultures of the flagellate. In hookworm infection flowers of sulphur has not been found of use. For hookworm the routine treatment which has been found most satisfactory consists in administering the thymol in three doses, instead of two, at 6:00, 7:00 and 8:00 A.M., followed by coffee at 9:00, Epsom salts at 10:00 and coffee and crackers at 10:30.

In addition to the humanitarian and medical points of view in the prosecution of the hookworm campaign, Dr. Stiles noted that the enormous waste of time, effort and expense in pregnancies that are to lead to children of inhibited development who will die before maturity as a result of hookworm disease, is a point that has made a considerable impression upon southern women.

MAURICE C. HALL,
Secretary

SCIENCE

FRIDAY, FEBRUARY 7, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION F—IS IT WORTH WHILE?[1]

THE first meeting of the American Association for the Advancement of Science was held in September, 1848. The society was not then organized into sections, but a committee on organization was empowered to "divide up sections" or "combine sections" as it deemed advisable.

The *Proceedings* of the Association indicate that for many years this committee was at least an active one, for the particular organization into sections and subsections of any one meeting rarely survived for another meeting.

At the sixth meeting, held in August, 1851, the following sections were recognized: A—Mathematics and Physics, B—Chemistry and Mineralogy, C—Geology and Physical Geography, D—Natural History, including Physiology, E—Ethnology and Geography, and F—Mechanical Science.

At the seventh meeting held in July, 1853, botany and zoology were recognized as subsections of Section B, which had been changed from "Natural History including Physiology" to "Chemistry and Natural History." The next year zoology was conspicuous by its absence, but two zoological papers were read in the subdivision designated "Physiology." The year following "Physiology" was omitted and "Zoology" was reinstated. Thus zoology, now prominent and now not in evidence, drifted in

[1] Address of the vice-president and chairman of Section F—Zoology—American Association for the Advancement of Science, Cleveland, December, 1912.

and out down to the thirty-first meeting held at Montreal in August, 1882. At this meeting "Biology," including botany and zoology, was designated as Section F and "Histology and Microscopy" as Section G.

For ten years the twins—botany and zoology—constituted Section F. At the forty-second meeting held at Madison, Wisconsin, in August, 1893, the twins parted company, zoology becoming Section F and botany, Section G. The Vice-president of Section F was Henry F. Osborn, who delivered the first vice-presidential address before the section. The secretary of the section was L. O. Howard.

But few vice-presidents have failed to follow the example of Vice-president Osborn. Two years ago sickness prevented the vice-president attending the meeting held at Minneapolis, but his address was read by another member of the section. Last year the vice-presidential address was omitted from the program because Vice-president Reighard and the other officers were convinced that but few zoologists would attend the Washington meeting. Their judgment was vindicated in so far as the number in attendance can be considered a vindication.

On the whole, the record of Section F as preserved in the *Proceedings* of the Association is very creditable and can hardly be called discouraging. Moreover, the list of zoologists who have taken an active part in the meetings of the association includes the names of most of our eminent and honored zoologists.

Why then ask you to consider whether it is worth our time and energy to maintain Section F as an active, vital unit in the Association?

Well, Section F can be thought of as an organism—at least it is an organization composed of living animal units—and I dare say it is no reflection upon you to assume that as zoologists we are all interested in living things and their functions and all the conditions that affect their vitality and effectiveness. But let me put you at ease, so far as I can, by assuring you that I am not going to tire you with an effort to work out this figure in detail.

The immediate suggestion and justification for my apparent disregard of the traditional character of vice-presidential addresses lie in the unrecorded facts pertinent to the life of Section F and in the attitude of indifference to and even open repudiation of the section assumed by some zoologists in recent years. It may be that the phenomena interpreted as evidences of destructive metabolism are merely expressions of efforts at readjustment. If so, I hope I shall be considered among those who desire a proper readjustment. If, on the other hand, the phenomena are indications of a real tendency toward disintegration, I trust I may have some part in at least checking that tendency long enough to enable us to come to a full realization of what disintegration of the section would mean for zoology in general.

Bear with me, then, while I bring to you some of the facts and observations which have a bearing upon the position of Section F as I see it.

Section F, as already stated, was organized in 1893. The objects of the section, as expressed in the constitution of the Association, are:

> by periodical and migratory meetings, to promote intercourse between those who are cultivating science in different parts of America, to give a stronger and more general impulse and more systematic direction to scientific research, and to procure for the labors of scientific men increased facilities and a wider usefulness.

The American Society of Naturalists was organized in 1883 with the object of associating

working naturalists for the discussion of methods of instruction, museum administration, and other objects of general interest to investigators and teachers of natural science; and for the adoption of such measures as shall tend to the advancement and diffusion of the knowledge of natural science.

The list of meeting places of this society clearly indicates that the society practically has been an eastern organization. The addresses and discussions, in so far as one can judge by their titles, indicate that some of the objects announced in section 2 of the constitution either have been overlooked or are not what the language of the section suggests.

In 1899 a call was issued to the naturalists of the central and western states to meet at Chicago for the purpose of considering the organization of a western branch of the American Society of Naturalists. This meeting was so encouraging that another meeting was held at the University of Chicago in 1900. The second gathering was even more successful than the first. Indeed it was so large that, in the language of the minutes, it "became necessary to hold two sections, a zoological and a botanical."

The segregation thus forced upon the botanists and zoologists in 1900 was again observed in 1901, when the Eastern Branch and the Central Branch of the American Society of Naturalists and the American Morphological Society met at the University of Chicago. At this meeting the zoologists appointed a committee on organization and during Convocation Week of 1902–03 organized the American Society of Zoologists, consisting of an Eastern Branch and a Central Branch. The constitution of this society declares the objects to be

the association of workers in the field of zoology for the presentation and discussion of new or important facts and problems in that department of science and for the adoption of such measures as shall tend to the advancement of investigation in that science in this country.

The scope of the society is further indicated by the restriction of membership to "active workers in the field of zoology and who have contributed to the advancement of the science."

The American Morphological Society was organized in 1890 in recognition of "a very noticeable increase in the number of persons in this country who are devoting themselves to the study of animal morphology," and also with a desire to break up the "scientific isolation" resulting from "the vast extent of territory over which our students are scattered." From the beginning this society was distinctively eastern, notwithstanding the fact that it recognized the vastness of our territory and expressed a desire to break up "scientific isolation."

In addition to the above there have been organized since the establishment of Section F, the American Association of Anatomists, the American Society of Biological Chemists, two societies of entomologists, the American Nature-study Society, the American Physiological Society, the American Psychological Association, the American Association of Museums and the American Breeders Association with a special section on eugenics. Each of these organizations has come into existence in response to a demand and each has some specific and circumscribed end or ends in view. All have drawn from the group of workers that but about twenty years ago constituted Section F. Membership in some of them naturally means separation from Section F, while membership in others ought to just as naturally mean active membership in Section F. For even when, as I have intimated, the declared objects of these organizations suggest a field of usefulness outside of the circle of the select

few the records do not suggest any activity beyond the circle. This is quite natural and under our conditions is inevitable.

I trust you will not misinterpret my brief comments on the declared objects of these societies. I am not criticizing, but am trying to present as briefly as possible some of the important facts and conditions that have a bearing upon my question.

Apparently there is still a demand for these organizations. All of them emphasize the fact that specialization and segregating grouping has become necessary. I dare say none of us will deny that the segregation of specialists is a natural process and that we shall always have the groups now organized, or others to be established as our points of view and interest shift. You may regret it and to some extent even rebel against it, but you can not ignore it and have a part in the progress of science. In yielding to this pressure, however, we may go to such an extreme as to fall far short of legitimate expectations. And I am constrained to declare that the tendency of eminent zoologists to ignore Section F and even to speak slightingly of it indicates a sad misconception of our relations to society at large.

Only the declaration of the American Society of Naturalists to adopt such measures as shall tend to the advancement and diffusion of the knowledge of natural science indicates a recognition of our obligations to all our fellow-citizens that is somewhat differently suggested in the "increased facilities and a wider usefulness . . . for the labors of scientific men" of the American Association for the Advancement of Science.

Neither the Society of Naturalists nor Section F has lived up to the program of general usefulness. The addresses, and quite naturally the papers, have been prepared with reference to the zoologists within the circle rather than with reference to those who are not specialists and in whom we should foster and develop an interest in the science for the general good.

In this, I think, lies the suggestion of the point where we shall discover our weakness and the hope for a wider influence and usefulness.

The Society of Naturalists can not be justified unless it really is what the name intimates, and under the present system of organizations and affiliations its meetings can not truly be meetings of naturalists unless the botanists, zoologists and other naturalists meet at the same place and time. The botanists have kept in close touch with Section G of the Association, but the zoologists have recently tended toward independence and separation from Section F by making the meeting places of the association a minor factor in the selection of the meeting places of their societies.

Are there any reasons why zoologists should emulate the example of the botanists and show a keener interest in the possibilities of Section F? I think there are, and I shall try to present one that has been uppermost in my thoughts recently.

I shall not enumerate the social and personal advantages of meeting at the same time and place set for numerous other scientific societies and sections of the association. These advantages have been fully presented and without doubt are admitted by all of us. At present there is uppermost in my mind just one point of view, namely, Section F as the zoologists' natural avenue to the general public.

As a foundation for my plea for a wider usefulness of Section F, I postulate the following two propositions:

1. No scientific organization in this country receives such general attention and, for a time at least, creates so widespread an interest in human knowledge

and achievement as does the American Association for the Advancement of Science.

2. Every department of science that appears as a part of the association at its meetings shares this touch with the general public in proportion to its activity and the interest it expresses in the public at large.

In my judgment these propositions are statements of facts and not inferences. Accordingly, I leave them without attempting to support them by argument, and ask: Can we as zoologists afford to ignore—nay, are we doing our full duty when we give little or no thought to our possible influence outside of the circle of our laboratories?

When I see men and women rushing from city to city or racing across the continent in automobiles in search of health or invigorating "rest," I soften my judgment with the fond hope that some day the zoologists and botanists of our universities, colleges and normal schools will send out teachers prepared to plant in the heart of every school boy and girl a love for nature that will become a heritage to be handed down from generation to generation as an invaluable asset for the health and happiness of the race.

Of course, the realization of this hope will not come until it is much more generally appreciated that, nature not being man-made, communion with her in "God's out-of-doors" compels man to leave the worn paths of human activity and diverts his attention to the things that are ever attractive and vitalizing. There are relatively few of us who are teachers, and still fewer of those who are preeminently investigators, giving due weight to this point of view. As a rule zoologists are either ignorant of or indifferent to the opportunity open to them for service in this direction, and in consequence are failing to fully discharge their sacred obligations to society.

Everywhere I find among thinking men and women a strong undertone of an unexpressed, an uncrystallized sentiment that for some reason or other zoology is not meeting a demand that ought to—that must exist in the best civilization. And whenever I have outlined a plan of what might be called natural history courses designed especially for teachers and prospective teachers, I have been most enthusiastically urged to carry out the plan and provide something similar for the students who are not selecting zoology or botany as the major line of work.

The love of living things as individuals in a community is inseparable from the social or gregarious instinct. And when we have reached years of discretion and instinctively seize essentials, letting go the non-essentials, we are still children at heart. The child humanizes the actions of the animals that come into its experience and names them as spontaneously as it does the cousins, uncles and aunts. And no matter how absorbed we may become in chromosomes, we are content and happy only when we call the animals we see and hear by name. The intellect may find satisfaction in the contemplation of the obscure and the abstract but the man of heart must have the concrete individual.

I venture to assert that every successful teacher of zoology who awakens an active interest in animal life and who fosters a love for nature is successful by virtue of his personal experience with animals in their native environment. A class tired and weary of the scientific discussion of a morphological or embryological question can be put on the *qui vive* any time with a story personal to some particular animal or group of animals. Time and time again I have seen students weary unto sleepiness awakened and kept awake for an hour by an account of a simple but personal ex-

perience with some animal. What teacher has not been struck by the tenacity and even accuracy with which students hold the accounts of personal experiences and the lessons drawn from them when their minds were like quicksand for morphological data!

But let us be honest with ourselves and remind ourselves that most of our students go out to give in miniature or in more or less condensed form what we give them in our laboratories and lecture rooms. The kind of zoology to which the great majority of the coming generation is to be introduced will be largely, if not altogether, determined in our universities and colleges by the men and women who constitute the membership of Section F and affiliated societies.

It should also be remembered that the wider the circle of those interested in a science the greater will be the appreciation of the work and efforts of the investigators in that field and the greater will be the possibilities in every direction. To take thought of service to the general public through our general courses in zoology from the schools to the colleges and universities and through such natural avenues to the public as Section F, is to indirectly but certainly increase the appreciation and support of all lines of zoological investigation and to give the investigator, as well as the teacher, in the field of zoology a more honored and generously supported position. Consequently, in view of the unique position I have assigned to Section F it is natural for me to bespeak a warmer interest in the section and a sympathetic cooperation for the officers.

Before concluding my brief plea permit me to protect myself against a possible misunderstanding. My plea is for Section F and the recognition of a need which I feel most of us do not recognize in service. In the presentation of this need and opportunity I am not decrying our present type of university course in general zoology. Neither do I advocate nor believe in replacing the usual university course in general zoology by a so-called old-fashioned natural history course or what some of the younger protestors are pleased to call ecology. No, I believe in what we may call the morphological course illuminated with a common-sense presentation of the machine in action and in its becoming. A critical examination of conditions I think will disclose as a fact that the protesting zoologists are misplacing their criticisms. The general dissatisfaction we hear about (which probably is not as general as some think it is) is not so much a result of the character of the courses offered as it is of the quality of our students. The courses, as a rule, are fit and proper and not a bit too exacting for a student of university caliber. But many of our students are not of university caliber in reference to zoology. That is the weak link in the chain. Our students should come from the high schools, preparatory schools and minor colleges with a better knowledge of animals as living individuals and with more knowledge of the physical sciences. But many of them come without any of this knowledge or with the background of a nature-study course often worse than nothing.

To crowd out of the university the exacting morphological course with a gossipy informational course of the hunter and fisherman and superficial poet is to replace sound learning and the development of mental fiber and capacity with sentimentality and undifferentiated—aye, undifferentiable protoplasm in the brain. We must not lower our standards and ideals to those of the vaudeville nor those of the moving picture shows nor those of the newspapers and current novels, but we must insist

upon keeping them up and do our best to make possible the proper preparation of the students.

With teachers prepared to teach zoology as probably we all feel it should be taught in our schools, and consequently with our students quite ready for a deeper look into animal life, and with a more widely distributed interest in zoological work, we shall find the more or less vague feeling for something that is wanting vanished and shall have a larger and more capable class of applicants for more special and advanced courses. Until this condition is realized we must as best we can provide for both classes of our students as well as for the preparation of the men and women who are to bring the rich blessing of a general interest in natural history to the commonwealth.

In the progress toward the realization of this worthy end Section F, in my humble judgment, can be made a most efficient factor by serving as the one sure and safe link between the general public and the zoologists as investigators and teachers.

The preparation being well done below the plane of the investigator, or, if you prefer, outside the circle of investigators, Section F will continue as a vigorous branch of a fruitful vine, and, being trained to meet the conditions of its general environment will yield to the people at large attractive, choice and satisfying fruit.

H. F. NACHTRIEB

THE UNITED STATES GEOLOGICAL SURVEY[1]

THE record of the work of the Geological Survey during the fiscal year 1912 may fitly be preceded by a statement of the conditions under which that work has been done, not as an apology for either the quantity or quality of the results of the investigations made, but rather as an exhibit of the limitations forced upon this bureau —limitations on economy and efficiency which seriously hamper all efforts for better administration in the expenditure of public money.

The offices of the Geological Survey have become wholly inadequate and unadapted to its needs. Since 1884, when the Survey was first quartered in the Hooe Building, at 1330 F Street, the effort has been frequently made to provide for the growth of the organization by adding wings and extensions to the building, but every increase in floor space has been made at the expense of proper lighting of the older portions of the building, so that its fitness for the Survey's use has been steadily impaired, and the resultant conditions constitute an actual detriment to health and a menace to life and property, as well as an obstacle to efficiency. The conditions under which the Survey employees work in the Washington office are to be condemned for both humanitarian and business reasons. . . .

The present housing of this federal bureau is unworthy of the nation. Both the work and the workers of the United States Geological Survey have an international reputation, and visiting foreign scientists do not conceal their astonishment at the miserable environment in which these investigations are being carried on. Our neighbors on this continent, in Canada and Mexico, have erected buildings especially adapted to the work of their geological surveys, which are properly housed, as is nearly every other geological survey in the world, and yet the geological survey of no other nation compares in size of organization or scope of work with that of the United States. In fact, the surveys of several of the larger European countries are organizations whose personnel is com-

[1] Extracts from the Thirty-third Annual Report of the Director.

parable in number only with that of single divisions of the American Survey.

The practical side of this feature is the increased inducement that suitable quarters would afford in retaining in the government service men of the highest professional talent. At best, most of these investigators are carrying on their government work at a financial sacrifice, and the temptation to go into professional or corporation work at largely increased salaries is strengthened by the contrast between the well-lighted and sanitary offices generally provided in the business world and the noisy, dirty, dark and crowded quarters offered by the Survey. To retain in the government service the best men is by far the largest administrative problem of the director of the United States Geological Survey.

Notwithstanding the growth of the Survey work along practical economic lines, scientific work has not been neglected. In fact, in the Geological Survey the scientific investigations are inseparable from the economic work, though the one or the other may predominate in purpose according to the needs of the particular research in hand. In any field economic work of the highest rank is impossible without full knowledge of the scientific laws and principles pertaining to the subject of the work; but as there is no application of geology which does not involve unsolved problems, some of them of the highest importance, the best knowledge available is nevertheless relative. It thus follows that the broad and searching observations which should accompany every piece of good economic work comprehend data that are eventually combined in the construction of new scientific hypotheses, some of which, as more observations accumulate, grow into established laws or principles that are in turn of the greatest practical consequence. Thus the detailed studies of the metalliferous deposits in one region or another bring to light evidence from which to determine the genesis of the ores and the modes or conditions of their occurrence, and the economic inquiry becomes more intelligent and successful when once this new principle regarding the mode of an ore occurrence is understood.

On account of the plain duty of this federal service to minister to the immediate needs of the various mining districts, it is not generally possible to concentrate and direct the observations to a series of regions systematically chosen as suited soonest to furnish the requisite data bearing especially on some particular scientific problem, however important and advantageous its solution may be; but nevertheless the data are gradually accumulated for the interpretation of many of these problems without sacrifice of the Survey's obligations to the public. An interesting illustration of the deduction of a principle from data so accumulated is found in the paper by W. H. Emmons on the enrichment of sulphide ores, the manuscript of which has been completed during this year. Another illustration of scientific results based on a long period of field studies, pertaining mainly to economic areas, is found in the pre-Paleozoic history of central North America, as described in the monograph by Van Hise and Leith on the geology of the Lake Superior region, which appeared during the year.

Among other long-term studies more distinctly scientific in character may be mentioned particularly the investigations, made under Mr. Vaughan's direction, of the formations of the southern Coastal Plain and Gulf embayment, which, though having an economic object, are yielding important contributions to our knowledge of the stratigraphy, physiography and

geologic history of this province; the work under the direction of Mr. Cross in the San Juan region of southwestern Colorado, which, in connection with the thorough geologic studies made during the preparation of folios, is affording new scientific results of a higher order concerning especially the volcanism and physiography of the region; and the studies begun last year by Messrs. Campbell and Alden in the Glacier National Park, which promise important results concerning the origin of the structure and physiography of this part of the Rocky Mountains and of the glacial topography, which, as it is still "in the making," offers exceptional opportunities for scientific study as well as observation by the traveler interested in the natural wonders of his own country. Important regional studies of high scientific rank which should also be mentioned are those prosecuted by Mr. Keith and his associates, on the difficult stratigraphy and intricate geologic structure of the older Paleozoic regions of western New England and the Appalachian region, the results of which are partly published in folio texts, and those carried on by Professor Emerson in southern New England. A report by Professor Emerson on the geology of Massachusetts and Rhode Island has been submitted during the year.

The paleontologic work of the Survey continues to be of the highest rank. Many of its publications, written by the most distinguished representatives of the various branches of paleontology in the country and embodying experience and observations gathered during years of patient research, have contributed much to the scientific reputation of the organization. The descriptive paleontologic papers are often treated as "pure science," yet instructive, striking or tedious, as may be these delineations of the groups of animal or plant life which lived on the globe in some particular epoch, there is not one of these papers describing the fauna or flora of a formation that does not prove sooner or later to possess practical value and to be essential to geology in its constantly increasing refinement of study and results. Without paleontology the geologic classification of formations, their correlation, and the determination of their mutual relations would be impossible. In fact, real and symmetrical progress in geology is impossible without corresponding interrelated development and refinement of its handmaid paleontology. The economic geology of any region of complicated structure is blind and inconsequent unless the time relations of the strata concerned are known. The monograph now being issued from the press on the Cambrian Brachiopoda, prepared by ex-Director Walcott and representing many years of painstaking study and distinguished attainment, embraces our best and most complete presentation of the criteria for the discrimination of the Cambrian formations in America and will for many years be a manual for the use of workers in Cambrian geology and paleontology. This monograph brings deserved credit to American science and to the Geological Survey, under whose auspices most of the work was accomplished. Other paleontologic publications specially deserving mention by reason of their scientific merit are J. P. Smith's philosophic treatment of the Middle Triassic faunas, and the monograph on the Mesozoic and Cenozoic Echinodermata of the United States by W. B. Clark and M. W. Twitchell, the manuscripts for both of which are now in hand. Work like that of Kindle on the Onondaga fauna, lately printed, and that by Berry on the Upper Cretaceous and Eocene floras of South Carolina and Georgia and by Stephenson on the Cretaceous deposits of the eastern Gulf region,

both now in manuscript, is indispensable to geology. In these papers the stratigraphic value and the practical application of the results of the paleontologic investigations are given much prominence. The two papers last named are based on materials gathered in the course of the study of the Coastal Plain already mentioned, the economic motive for which was the investigation of the underground water resources. They are therefore representative of a series of scientific reports resulting from studies whose immediate object is economic.

The folios describing and mapping in detail the geology of quadrangles in different parts of the country are regarded as mainly scientific, though always giving attention to the economic resources of the region. The areal studies now in progress in the valley region of central Alabama, a part of which has been described by Mr. Butts in the Bessemer-Vandiver and Montevallo-Columbiana folios, now in hand, promise important additions to the geologic history of the southern Appalachian region. On the other hand, the Claysville (Pennsylvania) folio, which has been issued during the year, affords a striking example of the first-hand aid in oil and gas development to be derived from the careful delineation of geologic structure and its economic explanation. Not inferior in scientific value to the papers just cited, though primarily economic, are such reports as those by Messrs. Brooks and Prindle on the Mount McKinley region, Alaska, and by Messrs. Calkins and Emmons on the geology and ore deposits of the Philipsburg quadrangle, in Montana.

An important and interesting effect upon the scientific work of the Survey has resulted from the work in land classification. The constantly increasing demand for both completeness and exactness of information regarding the mineral resources of the public lands under classification have developed methods and scope of view in this economic work that have exerted a marked influence on the folio work in other areas.

Thus, the training and methods developed in the course of the classification of the coal lands have brought about higher standards of refinement in stratigraphy, as well as in economic work, in other regions of the country. Another very notable illustration of scientific results springing from the study of economic problems is found in the administration of the Weeks Act. The intensive hydrometric experimental studies carried on in order actually to show, in accordance with the terms of the law, the degree of protection afforded by forests to soil and water in certain areas proposed for purchase as national forests have resulted in empirical determinations and demonstrations of high scientific value as well as of tangible economic importance.

The principles governing the origin and mode of occurrence of petroleum and natural gas are as yet but fragmentarily grasped. Every oil field examined in detail contributes its data for use in the eventual interpretation of the problems, and each pool is studied with keen alertness for the discovery of some key which may aid in the coordination of the data, which sometimes, according to the region and conditions, seem, on account of our lack of knowledge, even to be in conflict. The observations made by the survey geologists in the oil and gas fields of California and Kentucky promise to further the solution of some of the problems, and by pointing out the relations of oil and gas occurrence to the geologic structure of the regions examined they have rendered important scientific as well as economic aid in oil and gas development; but the basic

principles controlling the widely varied modes of occurrence and accounting for the differences in kinds of the oils in widely separated regions are possibly still far from view.

On account of the more conservative and dignified character of the official publications of the Survey and the care taken to confine their substance to matters of demonstrated fact, they do not offer to the geologist the forum for free discussion of scientific theories and problems that are afforded by those periodicals and serial publications of scientific societies which are especially devoted to matters of strictly professional interest and which are more widely distributed among scientists. For this reason many of the scientific results of the Survey's operations are first published in these journals. Examples of papers of high rank contributed in this way are numerous. Without implying relative merit among these, mention as typical may be made of the paper by Mr. Campbell, "Historical Review of Theories Advanced by American Geologists to Account for the Origin and Accumulation of Soil," published in *Economic Geology*, Vol. 6, No. 4, and that by Mr. Ulrich, entitled "Revision of the Paleozoic Systems," printed in the *Bulletin of the Geological Society of America*, Vol. 22, No. 3. Besides contributing to the programs of other scientific societies in Washington, the members of the Survey maintain for the discussion of purely geologic topics three professional societies, including the Geological Society of Washington, before which Mr. Campbell's paper, just cited, was presented as a presidential address. Meetings of some one of these societies or of their sections average two a week for the winter and by far the greater number of the papers read are offered by members of the Survey.

EDUCATIONAL WORK OF THE SURVEY

Closely connected with the scientific work of the Survey is its educational function, which has not, on the whole, received the attention that so importantly useful a work deserves. The Survey has, however, in cooperation with several state surveys, participated in the preparation of a number of educational bulletins that have, in accordance with the agreements, been submitted to the respective states for publication. As distinctly educational in their scope, though far from elementary, should be named the valuable paper by Mr. Willis, entitled "Index to the Stratigraphy of North America," published as a professional paper in explanation of the new geologic map of the continent, and the paper by Messrs. Tarr and Martin, describing the earthquake phenomena in the region of Yakutat Bay, Alaska.

A notable contribution to the study of physiography was the Survey's Professional Paper 60, "The Interpretation of Topographic Maps," by R. D. Salisbury and W. W. Atwood, consisting chiefly of reprints of parts of the Survey's maps and of brief suggestions as to the origin and history of the features shown on them. For many years the topographic maps made by the Survey have been regularly used in the courses of instruction in geography and physiography in most of the universities and colleges and to some extent in the secondary schools. It is very gratifying to note that the maps prepared in accordance with the present high standard, and more fully adapted to such use, are coming to the attention of teachers in the graded and country schools. Teachers of schools located in the quadrangles surveyed in recent years find the corresponding topographic sheets a most practical and invaluable aid to their efficiency and success in teaching elementary geography.

THE TRANSCONTINENTAL EXCURSION OF THE AMERICAN GEOGRAPHICAL SOCIETY

On the evening of August 21 there was gathered at dinner at the Harvard University Club in New York City a somewhat unusual company. Of those present forty-three were European geographers, representing fourteen different countries. There were also present about a dozen Americans, and all together were making the beginnings of acquaintance and friendship which in many cases will be lifelong. The occasion of the excursion was the completion on upper Broadway of the American Geographical Society's splendid new building. Though unannounced, it is well understood that the two months of journeying which followed was made possible through the munificence of the president of the society. The party had been organized, and the excursion was directed by Professor W. M. Davis, of Harvard University. The start was made from the Grand Central Station at 8:30 on the following morning. The special train was made up of two Pullman cars, two Pullman observation cars, a diner and a baggage car. There was also usually attached to the train a private car accompanied by some official of the several railways along which the route was taken. These officials were usually in charge of the land holdings and of the industrial operations which are now so largely promoted by our great railway systems in the west and the south. They are accomplished men and gave to the party many valuable lectures and conversations throwing light upon the development of their respective regions. A very complete outfit of maps had been provided, and the map expert of the society hung in the observation cars large and small scale maps appropriate to the regions through which we were passing daily. There were also considerable libraries, made up of the books and papers of the American members of the party and of the reports of the Geological and Geographical Surveys of the United States, and of the various commonwealths.

It would not be easy to define in a single sentence the object and work of the excursion. The main aim, of course, was for every man to get as much first-hand knowledge about the United States as possible. This was attained in many ways. There were considerable observations from the car windows so long as daylight prevailed, and there were many stops, sometimes two or three in a day, for special features of the physical geography. Thus, in Fishkill, a little more than an hour out of New York, the party alighted from the train and ascended by the cable car to the summit of the highlands, where one of the American members interpreted the topography of the mountains, and the industrial and commercial interests of the Hudson River lowlands as they spread out northward towards Albany. At Little Falls a brief stop was made. The Dolgeville railway was ascended to the top of the cliffs and the topography and history of the Mohawk Valley were briefly described, and a representative of the state engineer's office added an account of the Barge Canal. At Syracuse the party was taken by automobiles southward from the city to see on the hills the abandoned river channels and fossil Niagaras of the closing stages of the glacial time. On the banks of the Mississippi River in the early morning the train stopped for an hour while the party scrambled to the top of the bluffs to look out over the delta of the Chippewa, and the ponded waters of Lake Pepin. The topography around San Francisco was seen by a long walk through the rift valley, marked by the earthquake movements of 1906, and also by the railway ascent to the summit of Mount Tamalpais, whose magnificent panorama includes the city, the Golden Gate, San Francisco Bay and broad stretches of the Valley of California. At Loch Ivanhoe, in Colorado, the train stopped at the western entrance of the tunnel, and the party walked over the Hagerman Pass of the Continental Divide, rejoining the train at the other end of the tunnel. At Asheville, one of the local summits of the Appalachians was reached by automobile and here lunch was taken looking out upon the wilderness of peaks and endless forests that characterize the mountains of North Carolina.

In addition to daily studies of the physical features from the train and by special excursions, a great deal of attention was given to the phases of economic and industrial development, for it is recognized by all true geographers, and it is especially emphasized by the geographers of Europe, that the science does not come to its full fruition until it has taken in, not only the lands, but the interests and relations of those who live upon them. Every one knows that a wide field for such study is open to one who crosses our continent.

From Buffalo the party visited the Lackawanna steel plant and for an hour or more were transported up and down among the various buildings and furnaces upon flat cars provided by the company. At Niagara one afternoon was devoted to the power house and the various industries, and the whole of the following day given to the falls and the gorge, with many stops and brief lectures from experts by the way. In Chicago the party inspected in squads, according to their choice, the Stock Yards, the business methods of the Sears, Roebuck Company and the map-making plant of the Rand-McNally Company. A day was spent in the great open air iron pits of Hibbing, Minnesota, where again the party was transported by many miles of zig-zagging in a train of open cars to all levels of this greatest of iron mines. A characteristic stop of forty minutes was made in sight of one of the "bonanza" farms of North Dakota, where various phases of North Dakota agriculture were explained from the observation end by experts of the state agricultural college, the audience being assembled about the rear of the train. The Europeans were vastly interested in many phases of western agriculture, familiar to them by reading, but now seen for the first time. They and the Americans as well wondered at the extent to which dry farming has encroached upon the range country in North Dakota, Montana, Washington and other parts of the arid west. A notable example of such successful dry farming was seen in central Washington. The party alighted at a little station called Almira, and were met by twenty-five or thirty automobiles gathered from everywhere by the industry of a railway official, the main object being to see the Grand Coulee, some twenty-five or thirty miles of dry cañon once occupied by the Columbia River. On the way to this, however, a dozen miles or more of rolling country were passed, covered with splendid wheat fields, and the harvest was in progress by means of the combined reaping and threshing machines, drawn by motors or by teams of twenty horses. These crops were growing without irrigation in a region of perhaps twelve or fourteen inches of rainfall. In the Grand Coulee the party were entertained at an outdoor lunch on the ranch of a graduate of the University of Michigan, and the party learned then, as they learned many times in the west, that the graduates of our greatest universities are likely to be found wielding hard hands and wearing a pair of overalls. The after-dinner feature of this day was a good sample of broncho "busting," by the trained cowboys of the ranch. That particular day was finished by a visit to an irrigated fruit farm, where all the ladies of the region had apparently gathered, and the foreigners got a new treat in the shape of a hundred-foot table of sliced watermelon. At Tacoma the tallest member of the party, a Chicago professor, tried in vain to measure with up-stretched arm the diameter of a log which had been pulled up out of the pond, and was put to the saw under our eyes.

A few links in the excursion were made by trips over the water. At Toledo the party was entertained on the upper floor of a skyscraper, then taken across the foot of Lake Erie and up the Detroit River by boat. The blue waters of Puget Sound and the environing slopes of virgin forests and noble cities were likewise seen from the decks of a steamer. On the Mississippi River the party spent a happy day sailing from Memphis one hundred miles down the stream, watching the sand bars, snag boats, the means taken to protect the banks, the bordering forests, and it must be said—the lone steamer or two on waters that might carry the commerce of an empire. An old-fashioned landing was made

in the twilight, head on to the shore, but it was not exactly old-fashioned to clamber up thirty feet of sand and find at the top a brilliantly lighted train of palace cars with dinner served.

There was much of a social and educational sort. Perfection of arrangement was shown almost every day, when promptly on the scheduled moment the train pulled into the station and with equal promptness a local committee stood upon the platform, and motor cars or electric cars awaiting the party stood in the street. There was the opportunity for acquaintance with the best types of American, which was by no means small, and the American members of the party in response to oft-repeated questions as to the state of the political weather, found the same muddled and unpredictable conditions with which they had become familiar east of the Mississippi River. One of the early stops was at Ithaca, where Mrs. R. S. Tarr, bravely fulfilling the desire of her lamented husband, who was to have been a member of the excursion, opened her home for a reception. Here the party met such members of the Cornell faculty as were at home during the summer, and gained some acquaintance with one of our universities, as they did also in Chicago, in Madison and other places. Many representative people were met at dinners held in Chicago, Duluth, Portland, Salt Lake City, Denver, Chattanooga and many other places. At the dinner in St. Paul the governor of Minnesota evinced his good wit by saying that he had never expected to see so many people who knew so much about the earth and owned so little of it, while Archbishop Ireland on the same occasion made a speech which, if a little long, was every word interesting and inspiring. It was not a little interesting to the French professors who sat at his side that he was quite their equal in the finished use of their native tongue. It is hardly to be believed that one hundred representative business men of any eastern town would come out by train at six o'clock in the morning a distance of fifty miles to meet a delegation of scholars, but this was done by the men of Fargo, in North Dakota, and the skidding of the automobiles in the wet gumbo outside of Fargo gave one a lasting remembrance of the quality of the black prairie soil. One of the pleasant memories of the Pacific coast is the hours of inspection and entertainment on the campus of the new University of Washington in a glorious suburb of Seattle. Indeed if any European came to the coast cities expecting to find things a little crude, he was obliged to alter his conceptions, for he saw paved streets, splendid buildings and innumerable beautiful bungalow homes, embowered in blossoms and greenery that never fail during the twelve months. The friendliest of social times was had in the Muir Woods, a splendid reservation of redwoods near the Golden Gate, on the day when Mr. John Muir, Mr. Luther Burbank and Mr. Fred G. Plummer were members of the party. At the University of Utah the entire party sat on the platform at the chapel service attended by a thousand boys and girls and brief addresses were made by one German, one Swiss and one American professor. Santa Fe brought the party into an old Indian and Spanish realm, and after a morning with prehistoric remains, the old adobe church of San Miguel was visited, and the ladies and gentlemen of Santa Fe gave a reception in the museum, an old Spanish building, once the governor's palace, now used for purposes of archeology. It was not all archeology, however, for the refreshments were good, the attire might have been seen in Chicago or Philadelphia, and the reception was preceded by Indian war dances, with all the accompaniments of hideous sounds, feathers and barbaric display to which the civilized Indian is still able to return. On the home journey there was a Conference on Geographical Education held under the presiding of President Alderman at the University of Virginia. Here five of the foreign and two of the American teachers of geography gave addresses on the teaching of the subject in European and American universities, which will be published and circulated by the University of Virginia. In Washington there

were a number of interesting entertainments consisting of dinners and receptions by the Carnegie Institution, the officers of the Congressional Library, the Cosmos Club and other institutions.

It will not be forgotten that men of the diligent type of the German and other European professors must have made volumes of various notes, and the crop of papers and books on America that may be expected in the coming years on the other side of the ocean may well be surprising. Records by photography were not the least. One of the strenuous Frenchmen took at least one thousand pictures, and it was ascertained by one of the Swiss members who had something of a genius for statistics and inquiry, that about twelve thousand photographs were made by the party as a whole.

One who had two months' experience of the excursion must almost say that the home life on the train was larger and more valuable than anything else. It surprised all to find that vehicles on wheels could become so thoroughly homelike, and it was the ordinary experience for members of the party returning even from the best of hotels to say: "We are glad to get back to the train."

The permanent American members of the party were about a dozen in number and represented Harvard, Yale and Columbia Universities, the University of Cincinnati, the State Normal College of Michigan, the Universities of Wisconsin and Chicago, Colgate University and the American Geographical Society. Many temporary members were with the party for one, two or three days at a time, in regions where they could serve as guides and helpers by reason of their own studies. A daily bulletin was issued on the train giving each day a full outline of the itinerary and work of the following day. There were endless conversations in the sleeping cars, on the observation platforms, in the observation parlors, in the dining cars, on platform steps, and everywhere. There were lectures in the train and off the train, indoors and out of doors, and as the party melted down together toward the end there were entertainments, improvised Indian dances, by a young Swiss professor, occasional mock scientific papers, taking off the foibles of the party, cartoons from the skillful hands of a number of the foreigners—in brief those bits of fun which enliven weariness and make work effective. It is a tribute to the perfection of American travel that in two months, with an average party of sixty-five persons, but one meal was served on the train, outside of the dining car.

Nothing has been said in this story of the great places. Of course they were visited—the Yellowstone (six days), Crater Lake (three days), the Wasatch and Lake Bonneville, Great Salt Lake, and the irrigated fields and orchards of the valley, the Grand Cañon (the masterpiece of nature in North America), and not least, Phœnix and Roosevelt, where the Salt River Valley, the driest and hottest region of Arizona, is being turned into one of the gardens of the continent. Best of all was the acquaintance which developed and the friendships which were cemented. An eminent foreign professor in a fraternal gathering held in one of the cars before the train broke up said that he counted the excursion the culmination of his life, and he paid tribute to the universal hospitality that they had found, both among the home members of the party and the citizens of many communities, and he said that best of all, the men of Europe had come to know the American gentleman. Not only friendship must result, but broad and just views of America by a group of foreigners supremely qualified to understand. The excursion was a kind of geographical congress on wheels, and it was a means of international comity.

The final days in New York and the closing dinner at the Waldorf Astoria made a fitting end of the two months spent together. A memorial volume will be published which will include a history of the excursion by the author of this sketch, and a considerable number of geographical essays by European members of the party.

ALBERT PERRY BRIGHAM

SCIENTIFIC NOTES AND NEWS

Dr. Paul Ehrlich, of Frankfort, and Dr. Emil Warburg, the president of the "Reichsanstalt" at Charlottenburg, have been made members of the Bavarian-Maximilian Order for art and science.

Professor J. Hadamard, professor of analytical and celestial mechanics in the Collège de France, has been elected a member of the Paris Académie des Sciences in the section of geometry, in succession to the late Professor Henri Poincaré.

Dr. Paul Marchal, of the Agricultural Institute of Paris, has been elected to membership in the Paris Academy of Sciences in the section of anatomy and zoology.

The Herbert Spencer Lecture this year will be delivered by Dr. D'Arcy Wentworth Thompson, professor of natural history, University College. Dundee, on February 13. The subject of the lecture will be "On Growth and Form."

Sir Rickman Godlee, president of the Royal College of Surgeons, will deliver the Hunterian oration in the theater of the college on February 14.

Professor James Hayden Tufts, head of the department of philosophy in the University of Chicago, has been made chairman of the Illinois Committee on Social Legislation.

The Geological Society of London will this year award its medals and funds as follows: Wollaston medal, Rev. Osmond Fisher; Murchison medal, Mr. G. Barrow; Lyell fund, Mr. S. S. Buckman; Bigsby medal, Sir Thomas Henry Holland, K.C.I.E., F.R.S.; Wollaston fund, Mr. W. W. King; Murchison fund, Mr. E. E. L. Dixon; Lyell fund, Mr. Llewellyn Treacher; Barlow-Jameson fund, Mr. J. B. Scrivenor and Mr. Bernard Smith.

Dr. Friedrich Schott, of Heidelberg, known for his services in the cement industry, has received an honorary doctorate of engineering from the Technical Institute at Brunswick.

Major C. H. Hills is proposed by the council for election as the next president of the Royal Astronomical Society.

E. A. Wood, C.E. (Cornell, '08), has resigned as professor of civil engineering in Chang Ha College, Foochow, China, and left there on December 30. He expects to travel in North China and the Philippines and then return home *via* the Suez Canal.

The British secretary of state for war has approved of the following appointments on the army medical advisory board: as civilian physiologist, Dr. Leonard Hill, F.R.S., and as civilian sanitary expert, Dr. Henry S. Kenwood.

The annual meeting of the Chicago Academy of Sciences was held the evening of January 14 and the following officers were elected for the coming year:

President—Dr. T. C. Chamberlin.
First Vice-president—Dr. Geo. S. Isham.
Second Vice-president—Dr. Henry C. Cowles.
Secretary—Dr. Wallace W. Atwood.
For trustee to succeed himself for a term of six years—Mr. Frederick L. Wilk.
For membership in the board of scientific governors—Dr. N. S. Davis, Mr. Albert Dickinson.

Captain Roald Amundsen will speak at the University of Wisconsin on February 10.

Lieutenant Graetz, the German explorer, according to Reuter's Agency, is making preparations for an Anglo-German airship expedition across New Guinea. The airship is to be built in Germany, but to have an English name and to be manned half by Germans and half by Englishmen. The expedition will leave Europe in October and will be absent two years. Its base will be a transport stationed off the New Guinea coast. In May Lieutenant Graetz expects to be able to make a preliminary flight in the airship from Berlin to London.

At the meeting of the Sigma Xi Society of the University of Chicago, held in the Quadrangle Club on January 7, Dr. Aaron Aaronsohn, director of the Jewish agricultural experiment station at Haifa, Palestine, gave an address on the possibilities of increasing the world's wheat supply by the introduction of wild wheat from Palestine,

which is especially adapted to growth in arid regions.

MR. A. N. JOHNSON, state highway engineer of Illinois, delivered an address before the students and faculty of the College of Engineering of the University of Illinois, on January 15, entitled "The Present Status of Road Work in Illinois."

MR. DONALD F. MACDONALD, geologist of the Panama Canal, spoke to students of the department of geology of Columbia University on January 17 on "The General Geology of the Panama Canal Zone."

AT the recent meeting of the American Society of Zoologists at Cleveland, Ohio, the following resolution was presented and approved by the society:

In the death of Nettie Maria Stevens on the fourth day of May, 1912, this society loses one of its ablest members, one whose work upon the relation of the chromosomes to the transmission of sexual characters is of fundamental value. Entering upon these painstaking studies in her later years, she soon attained to a position of leadership in a peculiarly difficult field of research.

Her achievements were a credit to Bryn Mawr College, from which she obtained the well-deserved honor of the degree of doctor of philosophy, and in the world of science her place among cytologists is both secure and high.

DR. THOMAS VOLNEY MUNSON, who while engaged as a nurseryman at Dennison, Texas, made valuable experiments on the breeding of fruits, especially in viticulture, died on January 21, aged seventy years.

THE Earl of Crawford, who built an observatory at Dunecht and made contributions to astronomy, died on January 30.

THE U. S. Civil Service Commission announces several examinations for positions under the Department of Agriculture on February 24 and 26, including forest pathologist at a salary from $1,980 to $2,400; assistant forest pathologist, from $1,440 to $1,800; assistant in xylotomy, at $1,000; assistant in soil surveying, at $960 to $1,200; assistant in forest management, at $1,400; examiner of surveys, at $1,200 to $1,500, and assistant irrigation engineer at $1,200 to $1,600.

THE New York State Forestry Association was organized at a convention in Syracuse on January 16, attended by some fifty representatives of the various parts of the state. This association has for its object the fostering of genuine forestry progress in the state of New York, and in this enterprise it hopes to represent effectively the spirit of forest conservation in the state at large and of the various associations interested in the welfare of the forests of New York. During the convention valuable papers on forestry subjects were presented and the nearly fifty guests at the evening banquet were addressed by President Drinker, of Lehigh University, president of the American Forestry Association. The president of the association is Dr. Nathaniel Lord Britton, director of the New York Botanical Garden and Museums, and its secretary, Dean Hugh Potter Baker, of the New York State College of Forestry at Syracuse University.

THE State Microscopical Society of Illinois held its annual meeting on January 9, at which the following officers were elected:

President—Albert McCalla, Ph.D.
First Vice-president—Walter F. Herzberg.
Second Vice-president—Frank Harmon.
Treasurer—Frank I. Packard.
Corresponding Secretary—N. S. Amstutz.
Recording Secretary—V. A. Latham, M.D., F.R.M.S.
Trustees—M. D. Ewell, M.D., LL.D., D. L. Zook, S. S. Graves, M.D., B. U. Hills, H. F. Fuller.

The conjoint soirée with the Chicago Academy of Sciences set for February 12 has been postponed to March 12 on account of the extensive changes in the electric lighting of the academy building from the direct to the indirect system not being completed.

THE president and fellows of Harvard College voted, on January 27, to establish the Harvard University Press, for the publication of works of a high scholarly character. For some years the university publication office, besides printing the catalogues, department

pamphlets and other official documents, has found it possible, in spite of its limited resources, to issue from time to time a few special works, until it now publishes seven periodicals and more than eighty books, ranging from treatises on Indic philology to practical directions for American lumbermen. To organize and extend this activity, so as to make the university properly effective as a publishing center for scholarly books, is the object of the new foundation. The press announces several noteworthy volumes as in preparation, including books by the late Professor James Barr Ames, of the Law School, and by Professors George Foot Moore, Eugene Wambaugh, Arthur E. Kennelly, George L. Kittredge, Charles H. Haskins, George A. Reisner and W. B. Munro. The board of syndics who will decide on the books to be published are Robert Bacon, fellow of Harvard College, chairman; George Foot Moore, professor of the history of religion; Arthur E. Kennelly, professor of electrical engineering; George L. Kittredge, professor of English; Charles H. Thurber, member of the firm of Ginn and Company; Edwin F. Gay, professor of economics and dean of the graduate school of business administration, and W. B. Cannon, professor of physiology. The director of the press is Charles Chester Lane, for the last five years publication agent of the university.

It will be remembered that after the conference for the discussion of theories of radiation, held in Brussels in 1911, Mr. Ernest Solvay, of that city, established an International Physical Institute with an endowment of $200,000. An article by Professor E. Rutherford, in *Nature*, states that part of the income is to be devoted to the foundation of scholarships for the promotion of scientific research in Belgium, part to defray the expenses of international meetings to discuss scientific problems of interest, and the residue to be awarded in the form of grants to scientific investigators to assist them in their researches. For the first year, which terminates on May 1, 1913, a sum of about 17,500 francs is available for the latter purpose. It is the intention of the committee each year to give grants for special lines of work. As the first international meeting was engaged in the discussion of the theories of radiation, it is proposed this year to assist preferentially researches on the general phenomena of radiation, comprising Röntgen rays and the rays from radio-active bodies, general molecular theory, and theories of units of energy. The grants will be awarded without distinction of nationality by the administrative committee of the institute on the recommendation of an international scientific committee. The administrative committee is composed of Professors P. Heger, E. Tassel and J. E. Verschaffelt, of Brussels; the scientific committee is composed of H. A. Lorentz (Haarlem), Mme. Curie (Paris), M. Brillouin (Paris), R. B. Goldschmidt (Brussels), H. Kamerlingh-Onnes (Leyden), W. Nernst (Berlin), E. Rutherford (Manchester), E. Warburg (Berlin), and M. Knudsen, secretary (Copenhagen).

As the result of a conference which was held under the auspices of the U. S. Bureau of Mines last September, of men who are interested in the saving of the lives of miners, there has been formed a society known as the American Mine Safety Association, with headquarters at 40th and Butler Streets, Pittsburgh, Pa. This association, which is now enrolling among its members the leading coal and metal mine operators, mining engineers and mine safety engineers of the country, has for its purpose the conservation of the lives and health of the miner and a reduction in property loss due to explosions or fires in mines. It will attempt to place before the miners standard methods to be used in rescue work and in first-aid to the injured. The work of the Bureau of Mines in reducing the number of deaths in the mines has led to the adoption of many different types of rescue apparatus, such as the oxygen helmets which the rescuers wear in a gas-filled mine, and also to the use of many different methods of resuscitation and first-aid to the injured. Hundreds of mines within the last three or four years have been equipped with rescue apparatus, rescue corps and first-aid corps.

Many of these men who are called upon in emergencies have developed their own ways of doing things and it is the opinion of the organizers of this association that the most efficient methods and apparatus should be found through actual use and recommended to the mining industry as a general standard. Mr. H. M. Wilson, the engineer in charge of the experiment station of the Bureau of Mines at Pittsburgh, has been selected as chairman of the executive committee of the association and has been instructed to carry on the work of organization. Membership in the American Mine Safety Association is open to any individual, firm, corporation or society interested in the reduction of the loss of life and property in mines.

THE faculty of medicine of Harvard University offers a course of free public lectures, to be given at the Medical School on Sunday afternoons at four o'clock, as follows:

January 5—"Preventive Medicine in relation to Industrial and International Concord," Dr. Charles W. Eliot.

January 12—"The Care and Feeding of Young Children," Dr. John Lovett Morse.

January 19—"Leprosy and its Care in Massachusetts," Dr. Charles J. White.

January 26—"What the State Board of Health is doing to protect the Health of the Citizens of Massachusetts," Dr. Mark W. Richardson.

February 2—"The Sexual Instinct—its Abuse and Control" (to men only), Dr. Edward H. Nichols.

February 9—"The Responsibility of the Community for the Prevalence of Venereal Disease," Dr. Hugh Cabot.

February 16—"Dangerous Effects of Patent Medicines," Dr. David L. Edsall.

February 23—"Fresh Air, Exercise and Physical Condition," Dr. Edward H. Bradford.

March 2—"The Bladder Ailments of Men in Later Life" (to men only), Dr. Paul Thorndike.

March 9—"Ophthalmic Catastrophes," Dr. Myles Standish.

March 16—"How to cultivate Emotional Poise in an Emotional Age," Dr. George L. Walton.

March 23—"The Rise of Experimental Medicine," Dr. Howard T. Karsner.

March 30—"Tumor Diseases Peculiar to Women" (to women only), Dr. William P. Graves.

April 6—"The Management of Scarlet Fever and Measles," Dr. E. H. Place.

April 13—"The New State Psychopathic Hospital," Dr. E. E. Southard.

April 20—"The Effect of Occupation on the Hearing Power," Dr. Clarence J. Blake.

April 27—"The Hygiene of Pregnancy" (to women only), Dr. Franklin S. Newell.

May 4—"Treatment of some Emergencies of a Surgical Nature," Dr. Howard A. Lothrop.

May 11—"The Preservation of the Natural Teeth," Dr. Charles A. Brackett.

May 18—"Future Lines of Investigation of Infectious Diseases," Dr. S. B. Wolbach.

AMONG the features of the British Association meeting in Birmingham in September next, as noted in the London *Times*, will be a number of popular science lectures. In view of the central position of Birmingham a large attendance of members is expected, and a local fund of not less than £6,000 is being raised in order that the arrangements may be worthy of the city. A private canvass has already obtained the promise of nearly £4,000, and an appeal for further subscriptions will be made at an early date. Twenty-seven years have elapsed since the last visit of the association to Birmingham. The meeting this year opens on Wednesday, September 10, and continues until the 17th. On the first day, in addition to various meetings, there will be a reception of the foreign guests and in the evening the president, Sir William White, will deliver his inaugural address. The program for Thursday, September 11, includes sectional meetings, a conference of delegates, a garden party, a popular science lecture and a reception. Next day the morning is to be devoted to sectional meetings. In the evening a discourse will be addressed to members, and there is again to be a popular science lecture to the general public. Saturday will be given up to excursions which are being arranged by a special sub-committee, including the principal local archeologists, geologists and botanists. On Sunday there will be services at the Cathedral and other places of worship. Sectional meetings will again be held on the following day, and in the afternoon there is to

be a public function at the university. The local committee will entertain the distinguished visitors at night, probably at a theater. Tuesday, September 16, will be devoted to sectional meetings in the morning, and a conference of delegates and a garden party at the Edgbaston Botanical Gardens in the afternoon. In the evening there is to be another popular science lecture and a discourse to members. On the following day the meeting closes.

UNIVERSITY AND EDUCATIONAL NEWS

The regents of the University of Wisconsin have decided to ask the state legislature, now in session, for $1,000,000 to be appropriated in sums of $250,000 a year for four years, in order to provide and equip dormitories for men, a men's commons and union and a student infirmary. They have also voted to request the continuance of the present appropriation of $300,000 a year for the construction and equipping of academic buildings. For the further development of university extension work, the regents desire an increase of $25,000 a year. Owing to the reduction in the assessed valuation of personal property, resulting from the adoption of the income tax in Wisconsin, the university's fund for current expenses provided for by the three eighths of a mill tax, has this year fallen below the amount anticipated. The regents, therefore, have requested that the sum of $92,380 be appropriated to make up this year's decrease; that $175,000 be provided for next year's decrease, and $225,000 for the following year's decrease.

It appears from reports in the daily papers that Professor Willard C. Fisher, of Wesleyan University, known for his effective advocacy of legislation on behalf of the laboring classes of Connecticut, has been dismissed from his chair at Wesleyan University for stating that religion would benefit from the closing of churches for several years.

Former Dean W. A. Henry, of the College of Agriculture of the University of Wisconsin, has presented his private library to the agricultural college. It will be maintained largely for the use of the dean and director of the college and the station.

The whole staff of the college of medicine and surgery of the University of Minnesota having resigned, the regents have named the following committee to consider and make recommendations concerning the reorganization of medical teaching in the university: Dean Wesbrook, Drs. Moore, Green, Wilson (of Rochester), Tuohy (of Duluth), and Bratrud (of Warren), and the president of the university.

Mr. Alfred Knight Chittenden, forester in the U. S. Indian Service, Department of the Interior, has been appointed assistant to the director of the Engineering Experiment Station and lecturer on timber and timber resources in the College of Engineering of the University of Illinois.

Professor Edward C. Elliott, head of the education department at the University of Wisconsin, has refused the offer of the presidency of the University of Idaho recently made him by the regents of that institution.

DISCUSSION AND CORRESPONDENCE

CONN'S "BIOLOGY"

To the Editor of Science: In the last number of Science (December 28) I notice a review of Conn's "Biology," by M. M., in which the reviewer draws parallels between the subject in hand and some other sciences. It would seem that the examples selected were ill chosen to meet the point at issue. But this may be due to the fact that others look upon biology differently from the reviewer.

Biology, being the study of living things, must be concerned with either plants or animals. A book written by either of the corresponding scientists is likely to be more accurate in all details, within his field, than is a book written by a scientist engaged in the other of the two fields. To cover accurately both divisions of the subject requires a breadth of view, and a degree of detailed knowledge in each field, not often combined in a single individual; especially in these days of high specialization.

How much better will a sophomore understand the general conditions governing respiration after reading this book, in which the references in index are to animal respiration only, than from selected portions of two books showing that exchange of gases takes place both in plants and in animals?

Or what will a student understand from the statement (p. 226) that "in plants the supporting structure is, as a rule, developed better than in animals." Wherein is the oak "better" than the horse, in respect to its supporting structure?

Again what would a thinking student make of the statement (p. 234), "there are other materials made by the plants, like wood and leaves, which can not serve as food for animals," when he sees boring insects in wood, reads of beavers and their winter supply of tree trunks, and observes animals grazing on the leaves of plants?

And if any members of a domestic science class should notice the definition of yolk, page 249, as "deutoplasm (Gr. *deuteros* = second + *plasma* = substance), deposited in the egg for the nourishment of the young," when in all their cooking experience concerning eggs they are taught that the yolk is at the center, while albumen or "white of the egg" is deposited about this—what conclusions would they draw from "biology"?

No doubt a number of these misstatements are chargeable to the printers, but they should be eliminated in a second edition.

In the review signed M. M. one side of the subject is presented; in the above note, another viewpoint is taken—botany and zoology as constituting biological science.

Frederick H. Blodgett

Texas Experiment Station

As this work, lately reviewed in Science, will probably be used in many colleges, it may be well to point out a paragraph on distribution which certainly needs amendment:

The high mountain ranges are perhaps the most effectual barriers of all. Practically no animal or plant is able to cross over the higher mountain ranges. The Rocky Mountains effectually separate the eastern from the western slope, and the life on the two slopes of these mountains is quite different, though the climate may be much the same (p. 381).

It would be difficult to write anything more misleading. The life on the two slopes of the Rocky Mountains is not "quite different," except when climatic (especially moisture) conditions differ on the two sides. The statement as given is nearly true for freshwater fishes in Colorado, but quite untrue for the great majority of plants and animals.

Several other things in the book should be corrected. It is certainly misleading to write "primrose," instead of evening primrose, for *Œnothera* (p. 357). I do not understand why Onychophora (p. 378) are said to be centipedes. These and other such things are of course small matters in comparison with the large amount of excellent material in the book; but there should be no flies in the biological soup prepared for college students.

T. D. A. Cockerell

University of Colorado

THE REFORM OF THE CALENDAR

To the Editor of Science: With reference to my article on the reform of the calendar published in your number for May 6, 1911, Vol. XXXIII., pp. 690–2, I desire to call the attention of those who took part in the discussion at that time to further developments in the matter.

In the December number of the Esperanto *Scienca Gazeto*, published in Paris by Hachette & Co., Ch. Verax, editor, we are told that the Swiss government actually appointed the commission referred to in my article and since that time have received 30 different projects for the reform of the calendar, 14 of which were written in Esperanto and the other 16 in seven different national languages.

The commission is still open for additional proposals and it is to be hoped that all those who took part in the discussion in Science will send their proposals without delay to the address "Conseil federal" or "Schweizerischer Bundesrat" (Federal Council), Bern, Switzerland.

It is also to be hoped that all persons who approve of the proposition to reform the calendar will write to the Swiss Federal Council immediately, expressing their approval of and giving their ideas on the subject.

J. M. Clifford, Jr.

SCIENTIFIC BOOKS

Elementary Entomology. By E. Dwight Sanderson and C. F. Jackson. Ginn & Co. 1912. Pp. vii + 372.

"During recent years there has been an increasing demand for short courses in elementary entomology. For several years past the authors have been endeavoring to present such courses to their students, but have encountered the difficulty that no text-book was available which met their needs. This book is, therefore, the author's effort to furnish such a text for beginners. . . ."

In a brief introduction the authors point out the important rôle insects play in the transmission of disease, and emphasize their importance as agricultural pests. Their explanation of why insects are so numerous in individuals and in species is not clear. "The immense number of insects, both of species and of individuals, is undoubtedly due to their varied structure which enables them to live under all possible conditions. . . . Thus the insects possess such diversity of structure and habit that they are able to live under all external conditions, and on account of their immense numbers they have been able to adapt themselves to a changing environment which would have entirely obliterated classes or species few in number." In other words, insects are numerous because they are diverse in structure and are diverse in structure because they are numerous.

The book is divided into three parts: I., The Structure and Growth of Insects, 62 pages; II., The Classes of Insects, 208 pages; III., Laboratory Exercises, 84 pages.

In Part I. a brief chapter is devoted to the near relatives of insects. The figure of the spider illustrating the arachnida is from a photograph taken at such an angle that it does not show the division of the body into cephalothorax and abdomen mentioned in the text, but does show the modified antennæ (cheliceræ) which, according to the text, are not possessed by Arachnida. The treatment of the Myriapoda is inadequate even for an elementary text. No distinction is made between the Diplopods and Chilopods, and while the figure shows a Diplopod with two pairs of legs to each segment, the text says that "each segment bears a pair of legs." The same statement is repeated in the table on page 9.

The twenty-four pages devoted to the anatomy of insects show the same evidence of hasty and careless work. The original figure of a typical maxilla of the grasshopper (Fig. 11) omits the cardo. We are told that the mandibles are always essentially biting organs, though many of the copied illustrations show their piercing form. We would agree with the authors that the mandibulate mouth-parts of the different orders are "apparently homologous," but what reason is there for believing that the types of suctorial mouth-parts are "entirely dissimilar in structure and origin"? However, it is consistent with such a belief that the illustrations of the mouth-parts of the mosquito and horse-fly (18 and 20), "good examples of the piercing type," should be labeled without further discussion, according to radically different interpretations, and that Fig. 15 is referred to on page 18 as of dipterous mouth-parts, though it is correctly labeled as hemipterous.

We are told on page 24 that "the wings are strengthened by numerous thickenings called *veins*, whose number and position form the basis of the classification of families, genera and species." Then, important as the subject would seem to be, a half paragraph, accompanied by an incorrectly labeled figure of the wing of a house fly, is devoted to a summary of the Comstock-Needham system, while in the systematic portion thirteen dipterous wings labeled according to this same system are illustrated and the key to families uses another system which is not even mentioned —not to say *explained*—in the text.

In the chapter on growth and transformations of insects the authors fail to make very clear the real distinction between complete and incomplete metamorphosis. "The transformation of the butterfly from the caterpillar is a *complete* one, and is known as a complete metamorphosis. The growth of the grasshopper, on the other hand, is gradual and presents no striking changes, and is known as *incomplete metamorphosis.*" In view of this definition the elementary student will be at a loss to understand why later in the book the Aptera are said to have no metamorphosis. As illustrations of the types of metamorphosis an account is given of the life history of the squash-bug, differential locust, tent caterpillar and spiny elm caterpillar. The account of the squash-bug is apparently from first-hand observation, the others are poorly digested from Morgan and Weed. A confusing error occurs in the account of the differential locust; Fig. 66 shows five grasshopper nymphs of various sizes and the legend says "First three stages of the nymphs of the differential locust"; Fig. 68 shows the last two. The text says that the different stages will be found in Fig. 67, which is a picture of an egg mass.

Part II., The Classes of Insects, opens with a chapter on classification which the authors could improve greatly by adopting a more direct and concise style.

The orders are then taken up in the usual sequence and treated very briefly. There is a superabundance of good figures, mostly borrowed, and the text often takes the form of a running comment on the pictures in the style of a stereopticon lecture, rather than a connected account to which the illustrations are subordinate. Of the 496 figures in the book, 406 or over 80 per cent. are borrowed from other works or are from borrowed photographs. Is there not danger that the elementary student might get the idea from these borrowed pictures that entomology is a second-hand science? Most of the figures are good, but some could be greatly improved. Some of the cuts of butterflies attributed to Fiske are very poor; the specimens seem to have been slightly out of focus and the negatives thin and flat. The bronze copper butterfly is certainly not so rare that there is any excuse for using a photograph of a mutilated specimen. Fig. 116, labeled "A Myrmeleonid, the adult of the antlion," is a Chrysopid.

This portion of the work contains many misstatements, only a few of which can be noted here. The long rows of tree-cricket eggs in raspberry canes are still credited to *Œcanthus niveus* in spite of the recent work of Parrott (Fig. 110). In speaking of the armored scales, the surprising statement is made that "with the first molts the female loses her legs and eyes, and the body becomes a mere mass of yellowish protoplasm with long thread-like mouth-parts," etc. The American rose-slug is given one generic name in the figure (Fig. 385) and a different one in the text; a similar slip occurs in the case of the screw-worm fly (Fig. 376). On page 243 it is stated that most of the larvæ of the Hymenoptera live within the food, exception being made of the first two families (Tenthredinidæ and Siricidæ). This is an inaccurate statement in the case of the larvæ of most of the aculeates as well as many parasitica. The remarks upon the ovipositor of Siricidæ apply only to that family in the strict sense, and not at all to the other families, which we are forced from the keys to assume are included under the term Siricidæ. The only definition of the stigma that is found appears in the statement under Cynipidæ that they lack "the dark spot or stigma toward the end of the anterior margin of the wings." The largest Braconidæ are stated to be not over one eighth of an inch in length, and the largest Proctotrypidæ not over one twenty-fifth of an inch; an astonishing statement in view of the fact that the typical genera *Bracon* and *Proctotrypes* both contain species measuring 10 mm., not to mention still larger common forms in other genera.

In Part III., Laboratory Exercises, six chapters are devoted to the external and internal anatomy of insects, the comparison of different types of arthropoda and of insects, the study of mouth-parts, etc. These exercises

are carefully arranged, are well written and apparently have been tried out with elementary classes. These chapters form the most satisfactory part of the work.

In chapter XXII., Classification of Insects, keys are given by which the student is supposed to be able to determine insects to orders and families. Here the authors have not been so fortunate.

The classification of the Hymenoptera adopted (p. 319) is woefully inadequate even for a very elementary text, and does not represent any of the progress made within the last quarter of a century. Granting the diversity of opinion that still prevails in regard to many points of the classification of this order, there is, however, much that has been done within that time that can not properly be ignored.

The inclusion of saw-flies, gall-flies and parasitic Hymenoptera in one suborder, as contrasted with all the remaining groups (aculeates) in another, is indefensible. The inclusion of Lydidæ and Xyelidæ in the Tenthredinidæ, and of Cephidæ, Xiphydriidæ and Oryssidæ in with Siricidæ has no longer any justification. On the other hand, the best founded work on ants to-day recognizes but a single family, comprised of five subfamilies. It would seem that this position might at least be advantageously maintained in an elementary key which, for the sake of brevity, omits mention of many important families. Neither this course was followed nor the alternative of including five family groups. On the contrary, three family names appear in the key, Poneridæ, Myrmicidæ and Camponotidæ. The Dorylidæ, relatively unimportant in this country, as well as the very important Dolichoderidæ, are not mentioned. The latter includes the economically important Argentine ant (referred to in the text on page 259 as belonging to the Myrmicidæ) as well as several very common North American forms which the casual student is far more likely to frequently meet with than he is with any Poneridæ. By the key all the Dolichoderidæ would fall into the so-called Camponotidæ, with which they have no closer relation than have any of the other groups of ants. The term *Camponotidæ* for the group containing the genus *Formica* is used for Formicidæ, despite the fact that the superfamily name Formicina based on that genus is used directly above it—a rather astonishing neglect of the established customs as well as codes of nomenclature.

There may be some excuse for omitting from the key such families as Evaniidæ, Stephanidæ, Trigonalidæ, Sapygidæ and Mellinidæ, but to be consistent the equally uncommon Masaridæ should be omitted. But why is there no place provided for the Larridæ, Nyssonidæ, Philanthidæ, Pemphredonidæ and Crabronidæ, all of which are abundant in species and individuals? The majority of the species belonging to these families fall, according to the key, in the Bembecidæ, the others in Sphecidæ, but the division is along a line that can make no pretense of being natural or even convenient.

It might also be noted that there is no provision made for wingless Hymenoptera in the keys and that therefore the wingless parasitic species, the worker ants and female Mutillidæ can not be classified. The term Psammocharidæ is used for Pompilidæ or Ceropalidæ of older authors, but the name Proctotrypidæ is not replaced by Serphidæ.

The whole principle of key construction with the intention of omitting "less important" forms is open to grave objection. The result is that the student chancing upon a specimen of a non-included group (and in the present case such specimens will be legion) ends in running it out to a family to which it does not belong, and confident in the correctness of his labors and unsuspecting the untrustworthiness of the key, has it impressed upon his memory as one of the types of that family. A far better method, in fact the only defensible method where keys are presented, is to make them complete enough to provide correctly for *all* forms coming within their scope, and then if deemed desirable rare or less important groups may be bracketed or set in special type. Otherwise it were better the tables were omitted altogether.

The key to the families of Diptera is written by an eminent authority in that group and will doubtless prove one of the most valuable parts of the book. Unfortunately some of the smaller families are omitted. The most serious drawback, so far as the present work is concerned, is the fact that the old and complicated Schinerian system of wing venation nomenclature is used, but nowhere explained, the explanatory figures of wings of Diptera, as in the other orders, being lettered by the Comstock-Needham system. The wing of *Blepharocera* is figured, although the Blepharoceridæ are omitted from the keys and the text does not explain that the intricate maze of intersecting lines are not veins, but folds in the wing membrane. They will surely puzzle any one who does not appreciate that fact. "Second boscal" cell (bottom of p. 323) is probably a misprint.

The wings of Hemerobiidæ are not ordinarily opaque, as stated in the table on page 307. Only one family of Trichoptera is recognized, although all authorities to-day would agree in recognizing more. Only one family of Thysanoptera is recognized, despite the fact that modern authorities recognize two suborders and several families.

In the key to families of Hemiptera the first category is "wingless insects with fleshy unjointed beak," its alternative is "winged or wingless insects, with a jointed beak," but under the latter is a subheading which provides for wingless insects with the beak wanting! Further, the beginner would often experience difficulty in recognizing the jointed character of many Coccid beaks.

The Aphidæ are differentiated from Aleyrodidæ and Coccidæ by having "long and slender legs and transparent wings," while the two latter are said to have "legs short, wings usually opaque." It is hardly necessary to mention the many legless Coccidæ, as well as the long-legged forms (*Orthezia*, etc.).

In the table to Coleoptera the majority of families are omitted altogether, and so are very many in the Lepidoptera. In the discussion of the latter order no mention is made of a division into two suborders Jugatæ and Frenatæ, but the *butterflies* and *moths* are said to form two main divisions of the order. The wing of *Hepialus*, however, is figured and the jugum noted in the legend. Such an insufficient statement as "subcosta and radius of hind wing connected by a cross-bar" is noted in the characterization of Sphingidæ.

The work closes with chapters on collecting and preserving insects, which will be of great value to the student.

The book is well printed on good paper and the illustrations, as a rule, come out well; when properly revised, it will make a welcome addition to the rapidly growing list of entomological texts, from which the teacher can choose the one best suited to the needs of his students.

C. R. Crosby

Cornell University

Dynamic Meteorology and Hydrography. Part I., Statics. By V. Bjerknes and J. W. Sandström. Quarto. Pp. 234. Part II., Kinematics. By V. Bjerknes, Th. Hesselberg and O. Devik. Quarto. Pp. 175 (with atlas of 60 charts). Carnegie Institution, 1911.

The object of this treatise is to develop practical methods for the systematic study of the pressure, temperature, humidity, density and velocity of the atmosphere. On account of the difficulty of solving the differential equations of a viscous gas the methods are almost entirely graphical, elaborate tables being given that obviate the necessity of even ordinary integration. In Part I. it is assumed that the conditions of equilibrium are fulfilled along every vertical line. From the records of a balloon sent up with self-registering instruments for pressure, temperature and humidity, it is therefore possible to calculate the pressure and density at different heights. For facility of calculation the authors divide the atmosphere into sheets each about 1,000 meters thick, beginning at sea level, and find the average density and temperature of each sheet. To allow for the humidity and still use Boyle's law, as for dry air, a virtual temperature is used that is derived from the

humidity and the actual temperature. In some cases the authors prefer to use, instead of the sheets, the heights of the surfaces of equal pressure drawn at intervals of one tenth of an atmosphere. Less accurate results can also be found from observations at the earth's surface, assuming average values for the changes as one ascends vertically. By these two methods it is possible to draw level surfaces and vertical sections that show the pressure and density at different parts of the atmosphere. If the equilibrium were exact the surfaces of equal pressure, of equal density and the level surfaces would coincide. The more these surfaces differ from each other the greater the tendency to motion. Similar considerations are discussed for the oceans, but these do not at present appear to have the same importance as the atmosphere. The second part takes up the representation of velocity. From observations of small balloons the horizontal velocity in different localities and at different heights can be found. These results are averaged with respect to height for the sheets of the atmosphere that were used in the first part of the work. The lines of flow can now be drawn for each sheet and also the curves of equal velocity. In some cases the authors use "isogonal" curves, namely, curves of equal direction of velocity. The use of these curves to solve differential equations is credited to Sandström. It appears, however,[1] to be due to Massau, who called them "isoclines." Towards the end of the volume these diagrams are used to deduce the vertical motion of the atmosphere under the assumption that momentum is a solenoidal vector, a downward velocity indicating precipitation. A supplement of 60 excellent maps comprises conical projections of the earth's surface showing the contour lines, in 24 sheets, and examples of the preceding methods applied to actual cases. The middle of Part II. contains an elegant study of two dimensional vector fields and of the graphical treatment of the operations which occurs in the differential equations of hydrodynamics.

[1] See D'Ocagne, "Calcul Graphique."

It is to be hoped that the authors will complete their work by a third part, on the dynamics of the atmosphere, as distinct from the kinematics, including Professor Bjerknes's own work on this part of the subject, and also extend the period of six hours, which is the limit of their prognostications, at present. A fuller treatment of the thermodynamics of the atmosphere would also be desirable.

F. R. SHARPE

The Theory of Experimental Electricity. By W. C. D. WHETHAM, F.R.S. Second edition. Cambridge, The University Press; New York, G. P. Putnam's Sons. Pp. xi + 340. $2.50 net.

It gives us great pleasure to welcome a new edition of Mr. Whetham's text-book. This work presents the subject of electricity as a living science and is characterized by a wonderful freshness of treatment. It is thoroughly up to date and includes such matters as the thermodynamic theory of electrolytic cells, conduction through gases, radioactivity and the electron theory. Although of necessity brief, the treatment of these subjects is quite accurate. Excellent judgment has been shown in the choice of material and the newer branches of the science are exhibited in their proper relationship to the old. One of the striking features of the book is the combination of simplicity and accuracy in the proofs used in establishing the important principles of the science.

We regret to observe that two blemishes which we noticed in the first edition have not been removed. The treatment on pp. 35 et seq. of the force due to a charged plane as though the charge resided on both sides of the plane is cumbersome if not actually misleading. The proof on page 105, of the mechanical force on a current due to a magnetic field, is fallacious as it stands; although it is made to give the right result. This matter could easily be rectified without changing the method. We also think that it is high time that Franklin's proof that the charge resides in the dielectric were dropped from the text-

books. The inference from the experiment is fallacious; moreover the experiment does not work if the dielectric is dry and low potentials are employed, or, in any event, if the dielectric is a gas or a vacuum.

Despite these minor blemishes the book is an excellent one. The style is admirable and the whole treatment is calculated to inspire the interest of the student. We can thoroughly recommend its use with classes which have already had a general course in physics.

O. W. RICHARDSON

PRINCETON UNIVERSITY

SPECIAL ARTICLES

RELATIONSHIP OF THE INDIAN LANGUAGES OF CALIFORNIA

ANTHROPOLOGICALLY California has always been noted for its linguistic diversity, which has been accepted as being greater than that of any other part of the world. Since Powell's standardizing classification, which allotted 22 distinct families of native languages to the state, only one consolidation, that of Shasta and Achomawi, has been positively asserted and generally accepted. Two or three other pairs of languages have for some time seemed to be probably each reducible to a common origin; but the specific similarities determined were weakened by the frequent occurrence of both lexical and grammatical resemblances between many other families which there was no justification for connecting genetically. These grammatical resemblances have been several times discussed by us and attributed to the inter-influence of distinct families, due to geographical contact. The lexical similarities we have assumed, in all but a few cases, to be the result of borrowing. It became clear that until the degree and extent of this mutual influencing and borrowing among unrelated languages were more precisely ascertained, the relationships suspected in the few instances referred to were capable of explanation through such borrowing on a slightly more intensive scale, and would therefore never advance beyond the stage of probability. For this reason we undertook some time ago a comparison of more than 200 stem words in all the languages and dialects of California so far as material was available. From the time the material began to be assembled, some interesting results as to the character and scope of the borrowing of words commenced to appear; but after analysis of the collected information had progressed beyond a certain point, it became apparent that the only satisfactory explanation of the resemblances between certain languages was genetic relationship. On the basis of these indications the grammatical information extant on the same languages was reexamined, and in every instance was found strongly confirmatory. Lexical and structural similarities coinciding and being relatively abundant, true relationships have been accepted as established. The new larger families and their components are:

Penutian, comprising the groups formerly known as Maidu, Wintun, Miwok, Costanoan and Yokuts. This is a relatively large and compact family, occupying practically the whole of the drainage area of the great valley of California.

Hokan, comprising certainly Shasta, Chimariko and Pomo, probably Karok, and possibly Yana. The territory of this family is in the hill country to the north and west of the Penutian, and is more irregular.

Ritwan, comprising Yurok and Wiyot. No new proof on the previously suggested possible relationship of these two languages was obtained, except the negative evidence of complete lack of resemblances of both to any other family, which of course increases the weight of the similarities between the two, insufficient though these may yet be for absolute demonstration.

The number of distinct families in California is thus reduced from 21 certainly to 15 and possibly to 12.

Owing to the absence of one of the undersigned in Asia at the present moment, some time must elapse before our material and conclusions can be finally revised and published. For this reason the present announcement is issued.

R. B. DIXON,
A. L. KROEBER

CRITICAL CRITERIA ON BASIN-RANGE STRUCTURE

As commonly regarded, basin-range mountains constitute an orogenic type by themselves; novel, isostatic, youthful appearing. The hypothesis of their structure is one of the most brilliant concepts in the history of American geology; at the same time it is one of the most fanciful, as the severe testing of a generation amply proves. Singularly enough, the theory had its birth in a district where even its fundamental form seems to be entirely without representation.

At this day and distance the extension of the hypothesis to all the so-called fault-block mountains of the arid regions appears to be not only too broad a generalization, but quite unfortunate. Although I should not wish to be the first to make so sweeping an assertion as lately was done by Dr. Spurr, that no one has ever seen the fault-lines blocking out the desert ranges, his statement is almost literally true, as all recent critical evidence on the subject fully attests.

The attractive feature of Gilbert's theory of basin-range structure was of course the strong support it was thought to give to the now famous hypothesis of isostasy. Concerning some of the fundamental premises, I long ago entertained serious doubts. It has since been fully shown that there was decided error in determining the degree of completeness of the compensation that invalidated the conclusions.

With the challenge of the basin-range hypothesis there has come a demand for citations of concrete examples in support of the theory. Thus far, after the elapse of a full decade and after frequent repetition of the demand, the evidence has not been forthcoming. The Cricket Range, in Utah, recently described in this journal as furnishing a key to the problem, emphasizes this shortcoming. It is not the mere display of profound faulting that is the main desideratum. Abundant evidence of this kind is readily found in nearly every one of the desert ranges. In the majority of cases such faultings are found to have no relations to the present orogeny. Where, according to the hypothesis, the bordering faults should be they are not; but when found they are usually miles out on the intermont plains. The present sharp meeting of mountain and plain is now explained by causes other than dislocation, through ordinary stream-corrasion according to Paige, or through sheet-flood erosion as urged by McGee. Under a title of "Locus of Maximum Lateral Deflation in Desert Ranges" I have called attention to its eolative origin.

By displacement are explained the steep truncations of the transverse ridges of many desert ranges. That these bevelments are really fault-planes bounding the mountain-blocks will have to be more strongly supported than it is now, by direct and unquestionable evidence, before the assertion can be accepted. These rows of truncated ridges seem rather to mark the lines of battle between the planorasive advance of eolic degradation from the desert side and the normal stream-corrasion of the more moist mountain areas.

In the light of the recent advances in our knowledge of the prodigious amount of deflation which takes place under climatic conditions of aridity it appears that the generally accepted hypothesis of basin-range structure will have to be abandoned and the origin of the desert mountains ascribed to eolic erosion mainly, rather than to local tectonic displacement.

Charles R. Keyes

NOTE REGARDING THE RELATION OF AGE TO FECUNDITY [1]

In his valuable book on "The Physiology of Reproduction" Marshall,[2] in a section on the relation of age to fecundity, says (p. 590):

> The fecundity of the average individual woman may be described, therefore, as forming a wave, which, starting from sterility, rises somewhat rapidly to its highest point, and then gradually falls again to sterility. There can be no doubt that animals as a general rule tend to follow a similar law.

[1] Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 43.

[2] Marshall, F. H. A., "The Physiology of Reproduction," London (Longmans, Green & Co.), 1910, pp. xvii + 706.

A record of the entire breeding history of a rather remarkable ewe, of which I made a note some time ago for another purpose, illustrates this law in so clear a manner that it seems desirable to publish it with some discussion, particularly since the place of original appearance of the record is neither readily accessible nor likely to come to the attention of the biologist.

The record referred to was contributed to the *New England Farmer*[3] by Mr. Chas. Mattoon, of Lenox, Mass. The ewe in question was owned by one of his neighbors, Colonel Nathan Barrett, who, at the request of Mattoon, drew up the following account:

I hereby certify that I have owned a native ewe sheep, for the space of nineteen years, lacking a few days; having retained her usual vigor for seventeen years. But in the fall of 1822, I observed for the first time, and with no small degree of interest, that she slackened her pace, and went in the *rear* instead *of front*, which *she continued* to do for one year. After which, having nearly lost use of her eyes, and teeth, I took her under my immediate care for the last six months, until March, 1824, when she died with old age—having given me nineteen fleeces of wool, and borne me thirty-six full-grown lambs, viz.:

	Lambs		Lambs
April , 1806	1	1815	2
1807	1	1816	2
1808	2	1817	2
Apr. 3, 1809	3	1818	2
Mar. 29, 1810	3	1819	2
Making 6 lambs in 11		1820	2
months and 26 days.		1821	1
1811	3	1822	1
1812	3	1823	0
1813	3	1824	0
1814	3	Total	36

The general accord of this case with the law discussed by Marshall is obvious. Beginning with the minimum degree of fecundity possible (excluding absolute sterility) there is a rather rapid increase to a maximum, which is maintained for a time. This is followed by a decline in fecundity more gradual than the rise, ending finally in absolute sterility.

[3] Vol. III., June 3, 1825, p. 353.

The case is of especial interest in the present connection because of the fact that it is a *completed* record, carried to the natural end of life of the individual. Such completed breeding records are rare for higher animals.

It is of interest to make certain biömetric computations from these data. If the age of the ewe is taken as abscissa and the number of lambs born as ordinate one can calculate by the ordinary methods the arithmetic mean point of this animal's total fecundity period, and certain other constants of interest. The only difficulty in making such calculations arises from the fact that no precise statement is made as to the age of the ewe at the time when the published lambing record begins. It is altogether reasonable to assume, however, that (*a*) the first lamb recorded is the first one borne by this ewe, and (*b*) that she was about one year old when this lamb was born. These assumptions will be made in the calculating, and further it will be assumed that the abscissal classes throughout center at even years of life.

Making these assumptions I find:

(*a*) That the arithmetic mean point of this ewe's effective breeding life was at 8.57 years.

(*b*) That the median point in her breeding career was at 8.17 years. That is, she produced one half of her offspring before that age and one half after it.

(*c*) That the modal breeding point[4] (*i. e.*, the point of maximum fecundity per unit of time) was at 7.34 years.

Taking into account the 17 years in which some young were born I find the following constants regarding the number of lambs per birth:

Mean number of lambs per birth	2.12 lambs.
Standard deviation in number of lambs per birth	.76 lambs.
Coefficient of variation in number of lambs per birth	35.78 per cent.

These are intra-individual constants based on an unusually long and completed breeding

[4] Calculated by the approximate relation that the distance from mean to mode is three times the distance from mean to median.

history. For comparison the following intra-racial (inter-individual) coefficients of variation for fecundity in other forms are tabled:

Constants of Variation in Fertility and Fecundity in Various Animals

Organism	Character	Coefficient of Variation	Authority
Poland-China swine	Size of litter	27.411	Surface[5]
Duroc-Jersey swine	Size of litter	25.997	Surface[5]
Mouse	Size of litter	37.5	Weldon[6]
Horse	Fecundity[7]	24.771	Pearson[8]
Man	Number of children	48.41	Powys[9]
Domestic fowl	Annual egg production	34.21	Pearl and Surface[10]

It is plain that the individual variability in "size of litter" shown by this ewe is of the same general order of magnitude as that found in other organisms for fecundity characters.

RAYMOND PEARL

THE INDUCTION OF NONASTRINGENCY IN PERSIMMONS AT SUPRANORMAL PRESSURES OF CARBON DIOXIDE

IN a previous issue of this periodical,[1] I reported the results of some experiments to determine the relation of different pressures of carbon dioxide to the rate at which persimmons are rendered non-astringent by means of that gas. Two varieties were used in those experiments, *Taber 129* and *Hyakume*, as these are understood at the Alabama Experiment Station. I had already found that under normal pressure of pure and of approximately pure carbon dioxide[2] these varieties occupied from six to eight days in losing astringency, the *Hyakume* being the slower to respond to treatment. Under a pressure of 15 pounds of pure carbon dioxide, the period was found to be reduced to less than 46 hours. To be more explicit, 24 hours was found to be insufficient for either variety, while at the end of 46 hours all astringency had totally disappeared. The minimum period required at this pressure was not determined at the time for lack of material. It was, however, quite evident that the time necessary to render these varieties non-astringent at normal pressure of carbon dioxide can be reduced to less than one fourth at 15 pounds. It then remained until the season just closed to determine these relations more accurately and with reference also to still higher pressures. It is upon this work that I desire to submit at this time a preliminary report.

Meanwhile the results of experiments made by Dr. H. C. Gore[3] on the effect of carbon dioxide at normal pressure have appeared. The varieties which he studied include *Taber 23* and *Hyakume*, so that his results are distinctly pertinent in the present connection. Gore used a metal receiver especially designed by him to meet practical requirements, and, as indicated by his controls, is doubtless as efficient for exact experimentation as a glass receiver. The experiments with *Hyakume* were done at Macclenny, Fla., so that the fruits of this variety were not subject to the exigencies of transportation. As to these conditions, therefore, Gore's experiments may be regarded as directly comparable to my own, which also were done on the ground in metal glass and wooden receivers. Gore's *Taber 23* fruits were processed in Washington. As to the numbers of fruits used in Gore's experiments, only three of *Hyakume* were available.

[5] *Biometrika*, Vol. VI., pp. 433–436, 1909.

[6] *Biometrika*, Vol. V., pp. 442, 1907.

[7] Fecundity in this case means the fraction which the actual number of offspring arising from a given number of coverings is of the possible number of offspring under the circumstances.

[8] *Biometrika*, Vol. I., pp. 289–292, 1902. Actually only the moments of this fecundity curve are given at the place cited. From the moments we have calculated the coefficient of variation.

[9] *Biometrika*, Vol. V., p. 251, 1905.

[10] U. S. Dept. Agr., Bur. Anim. Ind., Bull. 110, Part I., pp. 1–80, 1909.

[1] Lloyd, F. E., "Carbon Dioxide at High Pressure and the Artificial Ripening of Persimmons," SCIENCE, N. S., 34: 924–928, December 29, 1911.

[2] The protocols of these and the remaining experiments will be published elsewhere in full.

[3] Gore, H. C., "Large Scale Experiments on the Processing of Japanese Persimmons, with notes on The Preparation of Dried Persimmons," U. S. Dept. of Agri., Bur. Chem., Bull. 155, May 20, 1912.

while of *Taber 23*, 68 fruits were processed, 71 serving for control. The three *Hyakume* were treated *in vitro;* the *Taber 23* in the metal receiver.

With conditions thus similar to those of my own experiments, Gore found that under normal pressure of carbon dioxide the *Taber 23* became nonastringent in two days and the *Hyakume* in 36 hours.[6] Previously[4] these had been found to yield to treatment in three days' exposure to vapor of alcohol of 5 per cent. and 25 per cent. strength in wooden tubs, the alcohol replacing, in this experiment, the *saké* of the empirical method of the Japanese. This result of Gore's I had overlooked at the time of my previous communication, or otherwise I should have been compelled to point out a discrepancy as between Gore's data and my own obtained *with alcohol vapor for which I* could not at that time have suggested an explanation. The discrepancy lies in the period required to render the fruit nonastringent with either carbon dioxide or alcohol vapor. Setting aside the *Taber 23* used by Gore as different from the *Taber 129* used by me, and therefore not comparable, the *Hyakume* in Gore's experiments yielded, under similar conditions, in less than one fourth the time required in mine; and, *with reference to carbon dioxide* alone, Gore succeeded in processing this variety under normal pressure in 36 hours, just the time, as it eventuated this year, required for apparently the same variety under 15 pounds. I do not argue from this that any doubt is thrown on Gore's work, nor would it be just to maintain the converse. It seems entirely probable rather that he and I have been working on different kinds. I have lately found that Japanese nurserymen on this continent recognize two subvarieties (using this term as a convenience) of *Hyakume*, the fruit of one of which becomes nonastringent while still firm and on the tree, while that of the other does so only after softening. It can scarcely be doubted that the former would appear to yield to the carbon dioxide treatment more readily than the latter. Furthermore, these physiological differences may not be confined to different races of the persimmon only, but may be highly individual, and different even in the same individual from year to year. In support of this I have to cite an important observation on the fruit of *Taber 129* growing at Auburn, Ala., on the station grounds. There are two trees, from which was obtained all the fruit for my experiments in 1911 and 1912. In 1911 the fruits from both the trees were, unless processed, uniformly highly astringent until softening was advanced. To render them nonastringent while still firm and crisp occupied 6 days in carbon dioxide alone at normal pressure. The fruit was tested each day, and there can be no doubt of the substantial correctness of the statement. In 1912, much to the surprise of both myself and my former colleague, Dr. F. A. Wolf, who aided me in carrying out the experiments to be presently mentioned, the *Taber* fruit apparently yielded to carbon dioxide at whatever pressure used, however low, and no matter how brief the treatment. But it was soon discovered that the real fact of the case was that *all the fruit was already nonastringent on the tree,* and this was true equally of fruits which were quite green and of those which were more or less of the definitive color, from yellow to deep orange. There were, moreover, in these fruits a very large number of reddened tannin masses, so that the inner portion of the mesocarp looked quite brown. That, however, this reddening of the tannin, due to oxidation, was not the cause of nonastringency is shown by the fact that the pulp was equally nonastringent where the oxidization had not occurred at all. I had previously ventured the opinion that the apparent absence of tannin from the nonastringent varieties might be due to the oxidized condition of the tannin, since I had been informed by Mr. Geo. C. Roeding, of Fresno, Cal., that the flesh of such kinds is freely interspersed with reddened cells. It now appears more probable that the reddening of the tannin masses is consequent on the nonastringency, and is not the cause of

[6] Gore, H. C., "Experiments on the Processing of Persimmons to render them Nonastringent," U. S. Dept. Agri., Bur. Chem., Bull. 141, September 29, 1911.

it; is indeed rather a result of the death of the tannin idioblasts,[5] and can be seen to proceed *in vitro* equally well, either spontaneously, but rather slowly, or rapidly under the effect of certain acids. It seems true, therefore, that the cause of nonastringency in all the varieties, whether they are the so-called nonastringent kinds or not, is the same. I have advanced an explanation of the phenomenon elsewhere[6] and the present issue does not call for a restatement.

In view of the possibilities in the case, therefore, I am bound to retain faith in the significance of the experiments upon which I based the conclusion that the higher the pressure of carbon dioxide, the shorter the period required to render the fruit nonastringent, especially as repetition and extension, in 1912, of the experiments of 1911 have discovered no discordant evidence.

The experiments were done during the first two weeks of September, 1912, at Auburn, Ala. The receivers used were four in number, all alike in construction. Each consisted of a piece of four-inch gas pipe two feet long, capped at both ends. A pressure gauge was inserted laterally, while each cap carried a gas cock, thus allowing the entrance and exit of the gas and air. This apparatus was cheap and efficient, but was not altogether easy to manage. It was necessary to work in a machine shop where pipe vises and large wrenches were at hand to screw home the large cap which had to be removed in order to examine the fruit. Graphite "dope" was used to make the joints tight. Though a pressure of 90 lbs. was in one case maintained for 24 hours, it usually fell a little, due to insufficient skill in getting every joint tight. The fall was, however, slight in any case, and, in view of the relations found, can be regarded as affecting the result but negligibly.

The fruits used were *Hyakume*, as stated, and *Tane-nashi*. For a supply of the latter I am indebted to Mr. C. L. Coleman, Fairhope, Ala., who was kind enough to send a large basket of choice material. For the name of this variety, I rely upon general acceptance in Alabama. The fruit answers also to the current horticultural descriptions. The *Tabor 129*, which had been used in the experiments of 1911, were excluded for the reasons above stated.

The condition of the fruit as regards maturity was various, ranging from complete greenness to partly orange, the intermediate shades of yellow, yellow-green and yellow-orange being represented—this in *Hyakume*. The *Tane-nashi* ranged from pale yellow to orange. It was found that the rate of becoming nonastringent was *as rapid in the green as in the more mature fruits so long as they were under the influence of the carbon dioxide*. If, however, they were insufficiently processed, and then kept exposed to the air, the subsequent changes were more rapid in the more mature fruits. Maturity then did not modify the immediate effect, and the range of condition in regard of maturity rules out error due to difference of ripeness. The fact is one, moreover, of prime theoretical importance.

In charging the receivers, a corresponding number of sets of fruits was chosen in such manner that each set contained the same range of color. The charge consisted of 8 fruits in each instance. Each fruit was selected carefully for its soundness, and no bruised or otherwise injured fruit was used, except in the case of the *Tane-nashi*, which, on account of transportation, was in some instances more or less bruised. This was, however, found to have no immediate effect on the rate of processing, though the keeping of the fruit thereafter was affected, as was true also of the other kinds.

In the several experiments[7] pressures ranging from normal to 90 lbs., were employed, together with controls in air. By charging

[5] Lloyd, F. E., "The Behavior of Tannin in Persimmons with some Notes on Ripening," *Plant World*, 14: 1–14, January 1, 1911.

[6] Lloyd, *l. c.*, note 5.

[7] While the results obtained with *Tane-nashi* are in general accord with those from *Hyakume*, they are not by any means as clear-cut and unequivocal. I shall therefore withhold them from the present discussion, but will embody them in a later account.

the receivers at different pressures and opening them at stated intervals, the period required for processing could be determined with all necessary accuracy, certainly within a very few hours. Both time and circumstance prevented a high amplitude of experimentation, so that pressures between 15, 25, 45, 75 and 90 lbs. were not tried. Concerning the highest of these (90 lbs.) it may be stated summarily that the fruit was killed, and on being taken out, at the expiration of 24 hours, was discolored (brown) and watery. It was, however, nonastringent. Whether the cause of death was due to rupture of the cells consequent on the too rapid increase or decrease of pressure, or on asphyxiation accompanied by change in permeability of the protoplast, I can not say. If the fruit was too soft, and the pressure released too rapidly, even when the initial pressure was no higher than 15 lbs., the fruit was burst, and microscopic examination showed that many individual cells were also in the same case.

The experiments were, moreover, designed to determine (1) the minimum period of time required to cause nonastringency at the pressures used; and (2) the after-effect of dosage at given pressures applied for periods insufficient in themselves to produce nonastringency. Aside from the theoretical interest attaching to the latter question, the possible economic application of short dosage, if followed by nonastringency within definite periods, was contemplated. The minimum period required to effect nonastringency was determined critically for normal, 15 and 45 lbs. pressure, the volumes of CO_2 being 1, 2 and 4, respectively. The after-effect of dosage at 45 and 75 lbs. was determined with sufficient accuracy to indicate definite quantitative relations.

It was found, in the first place, that at the end of 36 hours with 15 lbs. pressure (experiment 12 *a—d*, 1912) the fruits were nearly nonastringent. Further treatment for three hours produced complete astringency. It is probable that the period required is nearer 36 than 39 hours, but not less than the former nor more than the latter. At 45 lbs. 12 hours was found insufficient (experiment 11 *d*, 1912), while at the close of 15 hours there was a scarcely perceptible astringency (experiment 9, 1912). It may be recalled that the variety in question (*Hyakume*, an "astringent variety") had been found in 1911 to require 6–7 days at normal pressure, and less than 46 hours at 15 lbs. Controls in air this year remained hard and astringent during the whole period of experimentation, nearly three weeks. It therefore emerges that, as I have previously maintained, there is a quantitative relation between the amount of CO_2 available and the rate at which the astringency disappears. Green fruits yielded as readily to both pressures as yellow or pale orange, which appears to indicate that, during the natural course of events, after the fruit has its full growth at any rate, the tannin cells are ready for the change leading to nonastringency, and that this change is induced by some condition set up in the tissue external to the tannin cells themselves. The graph determined by the data above indicated is that of a rectangular hyperbola, and this may be held tentatively as expressing the relation of time and pressure to the disappearance of astringency.

In the second place, the fact was established that nonastringency ensues the more rapidly, the longer the exposure to CO_2, though this in itself is not sufficient to bring about the result. Pressures of 45 and 75 lbs. were used, the treatments being for 3, 6, 9 and 12 hours. After a pressure of 45 lbs. applied for 3 hours, nonastringency ensued in from 71 hours (for orange-colored fruits) to 192 hours (for yellow and green fruits). After 6 and 9 hours exposure, 45 hours were required, the evidence being that the period was somewhat less for the longer exposure. After 12 hours, the fruit became nonastringent in something over 18 hours. After 75 lbs. pressure, nonastringency was effected in a somewhat shorter period, but in view of the possible significance of the quantitative relations indicated above, but little difference should be expected between the results caused by 45 and 75 lbs. After 3 hours exposure, nonastringency followed in 62 to 185 hours; after 6 hours in something over 34 hours, after 9 hours less

than 34 hours, and after 12 hours in about 20 hours. In the receiver charged for 12 hours, however, the pressure fell from 75 to 50 lbs., so that no difference worthy of note may be seen as between this and the corresponding experiment for 45 lbs. The difference in effect of the 6 and 9 hour exposures was very small with both 45 and 75 lbs. pressure, a fact which I am unable to elucidate. Aside from this, the period required for becoming nonastringent was, roughly speaking, in inverse ratio to the time of exposure to the gas. It will be readily understood by those who have worked with such objects as ripening fruits that it is often difficult to fix upon a suitable indicator of the final limit of any of the physiological processes involved. Thus, in these experiments just described, the difference in rate of change in green and orange-colored fruits makes it difficult to decide on what is to be regarded as the final point at which nonastringency ensues. Furthermore, there is the more variation between different fruits the longer the period of ripening, and the end point is correspondingly difficult to fix.

I have, therefore, endeavored to apply a test different from that of tasting, at least for purposes of control. The mucous membranes are of course extremely sensitive; nevertheless, it becomes difficult, as the end point is approached, to judge clearly. It is furthermore of the highest importance to examine the physical characters of the tannin-mass, which has been shown to be a colloidal complex,[8] in order to determine whether the condition reached by it when nonastringency has been accomplished quickly is identical with that reached after a slow process. A former study of the reaction of alkaloids[8] with the tannin-mass showed me that as nonastringency is approached, the coarsely granular precipitate gives way to an increasingly finer one, so that an ultramicroscopic and eventually an amicroscopic suspensoidal condition is reached. The only change obvious on applying the reagent then becomes one of color, the tannin-mass becoming brown, lighter brown, darker and paler yellow as the definitive state is approached. By reflected light the changes are evident as a decreasing milkiness.[9] By correlating these progressive changes with the disappearance of astringency, it has become evident that it is quite possible to decide whether a fruit is astringent or not without tasting it. This is because the physical condition of the tannin-mass is the same on the arrival of nonastringency, whether this has been accomplished in 15 hours or as many days.

There remains one further point of which to speak. When one uses such an expression as "the period required to become nonastringent," an incorrect notion may be implied. It is not to infer that in one case the process itself is slow and in another rapid (though this may be the case), but that the time required to start the process may differ. It remains to determine the actual fact, and this is necessary to an understanding of the whole matter.

Note.—The work, of which the above is a partial account, was done at the Alabama Agricultural Experiment Station as an Adams Fund Project. I have to thank Dr. F. A. Wolf for hearty and arduous cooperation in carrying on the experiments.

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[8] Lloyd, F. E., "The Tannin-colloid Complexes in the Fruit of the Persimmon," *Biochemical Bulletin*, 1: 7, September, 1911.

[9] These changes are analogous to those seen first by Loew and others, and recently described in detail by Czapek. Czapek, F., "Ueber Fällungsreactionen in lebenden Pflanzenzellen und einige Anwendung derselben," *Ber. deut. bot. Ges.*, 38: 147–159, 1910.

THE AMERICAN PHYSIOLOGICAL SOCIETY

THE society held its twenty-fifth annual meeting in Cleveland, Ohio, December 29, 1912, to January 1, 1913. Sixty-nine members were in attendance. Two executive sessions and six scientific sessions were held, two of the latter being joint sessions, one each with the American Society of Biological Chemists and Section K of the American Association for the Advancement of Science. The joint session with the American Society of Biological Chemists was opened with exercises in memory of the late Waldemar Koch. After the

members of the society had arisen as a token of respect to the memory of Dr. Koch, Dr. A. P. Mathews delivered the memorial address.

The following papers and demonstrations, forty-seven in all, were read and discussed:

S. Simpson: "The Rate of Growth in the Dog."

G. N. Stewart: "Further Observations on the Blood-flow in Man."

J. A. E. Eyster and W. J. Meek: "Experiments on the Sinus Region of the Mammalian Heart."

G. C. Robinson (by invitation) and J. A. Auer: "Cardiac Anaphylaxis as Shown by the String Galvanometer."

W. T. Porter: "The Functional Relations of Cells in Nerve Centers."

R. S. Lillie: "Correlation between the Anti-stimulating Action and the Anti-cytolytic Action of Anesthetics."

E. B. Meigs: "Studies in the General Physiology of Smooth Muscle."

W. P. Lombard: "The Tickle Sense."

O. Folin, W. B. Cannon and W. Denis (by invitation): "A New Colorimetric Method for the Determination of Epinephrin."

J. Auer and S. J. Meltzer: "The Splanchnic as a Depressor Nerve."

F. R. Miller: "The Salivary Secretion Centers in the Medulla."

W. T. Porter: "A New Electrical Clock."

S. P. Beebe: "A New Form of Apparatus for Artificial Respiration."

A. D. Hirschfelder: "Some New Apparatus."

L. Loeb: "The Influence of Pregnancy on the Cyclic Changes in the Uterus."

G. Lusk: "Metabolism of a Dwarf."

H. S. Gasser (by invitation) and A. S. Loevenhart: "The Mechanism of Stimulation by Oxygen Want."

T. B. Osborne and L. B. Mendel: "Feeding Experiments Relating to the Nutritive Value of the Proteins of Maize."

A. J. Ringer: "The Fate of Fatty Acids in Diabetic Organisms."

A. B. Macallum and W. R. Campbell: "On the Secretion of Pure Acid by the Kidney" (with demonstration).

D. Marine: "Hypertrophy and Hyperplasia of the Parathyroid in Birds."

G. H. Whipple: "Hematogenous Jaundice and its Relation to the Liver."

E. V. McCollum: "The Influence of the Plane of Protein Intake on Nitrogen Retention in the Pig."

R. S. Hoskins: "Relation of Fatigue Metabolites to Epinephrin Efficiency."

D. R. Hooker: "Perfusion of the Respiratory Center in Frogs; the Influence of Calcium and Potassium on the Respiratory Rhythm."

A. Hunter: "The Nitrogen Excretion of Normal and of Thyroidectomized Sheep."

A. L. Tatum (by invitation): "Studies in Experimental Cretinism with Suggestions as to a Biological Test for Thyroid Secretion."

R. A. Gesell (by invitation): "The Relation of Pulse Pressure to Renal Secretion."

C. Brooks and A. B. Luckhardt: "The Arterial Blood Pressure during Vomiting."

T. Sollmann and J. D. Pilcher (by invitation): "The Effects of Aortic Compression on the Circulation."

E. G. Grey (by invitation) and A. D. Hirschfelder: "Clinical Observations upon the Carbon Dioxide Percentage of Alveolar Air."

C. W. Greene and W. Y. Skaer (by invitation): "On the Fat Contents of the Mammalian Gastric Glands in Relation to the Stages of Digestion."

S. Tashiro (by invitation): "The Chemical Change in Nervous Tissue during Excitation."

I. F. Zucker (by invitation): "The Pressor Property of Shed Blood."

H. Cushing, L. H. Weed (by invitation) and C. Jacobsen: "Further Studies on the Rôle of the Pituitary Gland in Carbohydrate Metabolism, with Special Reference to the Autonomic Control of the Posterior Lobe Secretion."

S. A. Matthews and D. D. Lewis (by invitation): "The Pars Intermedia; Its Place in Diabetes Insipidus."

Lydia M. Degner (by invitation) and A. E. Livingston (by invitation): "Effects of Thyroidectomy and Castration, respectively, on the Pituitary in the Rabbit."

P. W. Cobb and L. R. Geisler (by invitation): "The Influence on Foveal Vision of the Brightness of Surroundings."

D. E. Jackson: "Some Observations on the Peripheral Action of certain Drugs."

G. L. Kite (by invitation): "The Relative Permeability of the Surface and the Interior Portions of the Cytoplasm of Animal and Plant Cells."

J. D. Pilcher (by invitation): "The Excretion of Nitrogen Subsequent to Ligation of Successive Branches of the Renal Arteries."

W. E. Burge: "The Uniform Rate of Destruc-

and Surgeons; H. G. Barbour, Yale Medical tion of Ptyalin and Pepsin by the Electric Current."

G. H. Whipple: "Intestinal Obstruction; Study of a Toxic Substance Present in the Intestinal Mucosa."

S. J. Meltzer: "Is the Pulsation of the Anterior Lymph Hearts Responsible for the Action of some Drugs in Cardiectomized Frogs?"

H. McGuigan: "The Synergic Action of Morphine and Strychnine."

Symposium: "Some Recent Applications of Physical Chemistry in Biology."

(a) A. B. Macallum: "Surface Tension."

(b) L. J. Henderson: "The Control of Neutrality in the Animal Body."

The following eleven papers were read by title:

C. D. Snyder: "The Influence of Temperature on the Mammalian Heart."

M. Dresbach (by invitation): "A Bloodless Method of Recording Blood Pressure in Animals."

A. J. Carlson: "Some Observations on the Physiology of the Empty Stomach and Esophagus in Man and Dog."

H. C. Bradley: "The Problem of Enzyme Synthesis."

G. W. Crile: "The Relation between the Physical State of the Brain Cells and Brain Functions—Experimental and Clinical."

Y. Henderson and C. T. Flynn (by invitation): "Oligemia in Acute Disease."

H. McGuigan: "The Secondary Depression by Epinephrin; the Rate of Destruction of the Pressor and the Hyperglycemia Actions of Epinephrin."

W. B. Wherry (by invitation): "On the Transformation of Amebæ into Flagellates and Vice Versa."

P. E. Howe (by invitation) and P. B. Hawk: "The Influence of Fasting on the Creatine Content of Muscle."

C. D. Snyder: "A Study of the Electromyograms."

A. J. Carlson: "The Correlation of the Physiological States of the Thyroid of the Fetus and of the Mother."

The following persons were elected to membership in the society: G. C. Robinson, Rockefeller Institute; J. D. Pilcher, P. J. Hanzlik, R. S. Pearce, Western Reserve Medical School; G. C. Schneider, Colorado College; A. H. Ryan, University of Pittsburgh; M. Dresbach, Cornell University; G. Bachmann, Atlanta College of Physicians School; W. B. MacNider, University of North Carolina; A. R. Moore, University of California; H. B. Williams, Columbia University; V. H. K. Moorhouse, Washington University.

At this meeting considerable progress was made toward the formation of a close federation of the American Physiological Society, the American Society of Biological Chemists and the American Society for Pharmacology and Experimental Therapeutics. The society expressed its desire to enter into such a federation, and a committee was appointed to confer with similar committees of the sister societies with a view to bringing it about. The committee was granted power to make the arrangements for the next annual meeting. This committee was also directed to confer with a similar committee of the American Society of Naturalists to consider the advisability of establishing closer relations with that society.

With regard to the measures of remedying the threatening congestion of programs that were referred to the council at the last annual meeting, it was decided that should the federation of the three societies be accomplished, the secretaries of the federated societies be empowered to attempt the equalization of the programs of the three societies by placing papers on the program of the society to which its subject is most closely related. It was also decided to place at the end of the program papers presented by non-members, and in the event of congestion of the program, to read these by title.

The following officers were elected for the year 1913:

President—S. J. Meltzer, New York.

Secretary—A. J. Carlson, Chicago.

Treasurer—Joseph Erlanger, St. Louis.

Additional Members of the Council—W. B. Cannon, Boston; F. S. Lee, New York.

The following members of the society were appointed by the president to form the editorial committee on the publication of the *American Journal of Physiology* for 1913: A. T. Porter, A. J. Carlson, Joseph Erlanger, W. H. Howell, F. S. Lee, Graham Lusk, S. J. Meltzer.

The local committee on entertainment, following the plan that was first tried last year at Baltimore by the members and friends of the society, again agreed to dispense with all private entertainment, and to substitute for it informal subscription dinners followed by smokers each evening while the society was in session. These functions were open to all members and guests of the societies of the experimental biological sciences. It was again

demonstrated that this method of entertainment, by bringing all of the members together under conditions permitting of informal discussion and exchange of ideas, adds greatly to the pleasure and value of the meeting.

JOSEPH ERLANGER,
Acting Secretary
WASHINGTON UNIVERSITY MEDICAL SCHOOL

THE ASSOCIATION OF AMERICAN GEOGRAPHERS

THE Association of American Geographers held its ninth annual meeting at New Haven, Connecticut, December 27–28, 1912. The sessions were held in Lampson Hall, Yale University, and an informal meeting took place Friday evening at the Graduates' Club. In the absence of the president (Professor Salisbury), Mr. M. R. Campbell, the first vice-president, presided. About thirty members attended.

It is gratifying to the members to see the increasing number of papers on anthropogeography, regional geography, and climatology that deal with human relations, a feature less prominent in the earlier programs of the association. Seven purely physiographic papers were presented out of a total of sixteen. Great interest is manifested in the *Annals* of the association since the appearance of the first volume during the past year. The publication committee has performed a distinct service to geographic science in securing papers of high quality and a volume of excellent appearance.

The newly-elected officers for 1913 are as follows:

President—Henry G. Bryant.
First Vice-president—Ellsworth Huntington.
Second Vice-president—Charles C. Adams.
Secretary—A. P. Brigham.
Treasurer—F. E. Matthes.
Councillor (for three years)—R. DeC. Ward.

The publication committee appointed for two years (1913 and 1914) consists of R. E. Dodge, editor, and Alfred H. Brooks, H. E. Gregory and H. H. Barrows.

ISAIAH BOWMAN,
Acting Secretary, Session of December, 1912

THE CONVENTION OF THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

THE sixth annual convention of the American Society of Agricultural Engineers was held at the Great Northern Hotel, Chicago, December 26, 27 and 28. The attendance of members was very good, but the noticeable feature this year was the unusually large number present of manufacturers, designers, etc. This is very encouraging to the officers and shows that the work of the society is being kept practical enough to interest the commercial man.

Thursday afternoon was devoted largely to general agricultural machinery interests. Mr. Sjogren, of the University of Nebraska, presented a paper on "Tests of Corn Planters," which gave the results of a series of tests run on accuracy of drop. Professor C. A. Ocock, of the University of Wisconsin, in his paper on "Draft of the Plow," showed by tables and curves, the variations in the draft of a plow as affected by width, depth, type of moldboard and condition of soil. In the paper on "Isolated Gas-lighting Plants" Mr. Eugene Becker, of the Atlantic Blau-Gas Company, described the different systems using gasoline gas, acetylene and Blaugas, with the advantages and disadvantages of each. Admixture of a certain proportion of air made either of these gases explosive, either a richer or leaner mixture being non-explosive: gasoline—2 per cent. to 5 per cent. by volume of gasoline vapor—98 per cent. to 95 per cent. air; acetylene—2 per cent. to 49 per cent. by volume acetylene—98 per cent. to 51 per cent. air; Blaugas—4 per cent. to 8 per cent. by volume Blaugas—96 per cent. to 92 per cent. air. Thus acetylene has a very wide explosive range, Blaugas next, and gasoline least. On the point of quality of light, acetylene is the best, but for convenience and safety Blaugas was probably most satisfactory.

Friday was devoted to the tractor and standardization questions. In his paper on "Testing of Gas Tractors" L. W. Chase, of the University of Nebraska, reviewed the results secured through the Winnipeg Motor Contests. C. F. Hirschfeld, of Cornell University, in a paper on "Principles of Fuel Oil Engines" explained the matter of carburetion of various fuel oils, the principles and chemistry of their combustion and the difficulties met in adapting them as fuels for internal combustion engines. E. H. Ehrman, of the Chicago Screw Company, in his paper on "The Standardization Work of the Society of Automobile Engineers," gave the society an account of the methods and guiding principles for the standardization work of his society. The influence of standardization in cheapening production and repairs and in keeping down monopoly was brought out in

"Standardization in Agricultural Engineering" by J. B. Davidson, of Iowa State College. This subject was continued by "Standards in Agricultural Machinery," by J. A. King, of Sears, Roebuck and Company. W. J. Brandon, of the Avery Company, in his paper, "Standards in Gas Tractor Construction," took up the question of standardization as applied to the gas tractor industry.

Saturday was set aside for papers along the teaching phase of the work. A paper by Daniels Scoates, of the Mississippi Agricultural College, on "Laboratory Exercises in Farm Machinery," brought out the fact that the subject naturally divides into farm mechanics, farm motors and farm machinery. "The Design of an Agricultural Engineering Building," by H. C. Pamsower, took up the design of a proposed building for the Ohio State University. The plans as shown were discussed by E. A. White, of the University of Illinois, and J. L. Mowry, of the University of Wisconsin.

The committee on the proposed Bureau of Agricultural Engineering reported through J. B. Davidson that the society should lend all possible aid towards securing the passage of the Rainey bill in its present form, providing the creation of a Bureau of Farm Power, inasmuch as parts of the work proposed to be included in the wider plan is already partly taken care of under different bureaus and there would be great opposition towards making the necessary reorganizations.

Extensive changes were authorized in the constitution of the society, especially as to classes of members, qualifications of members, methods of electing members, and in dues. The intention is to make the requirements for active membership more rigid, but to provide a wider range of membership through associates, juniors and affiliates. Originally composed of college men engaged in the teaching of agricultural engineering subjects, the society has been broadened to include manufacturers, technical men, etc. The increase in membership has been rapid, that of the present year being between forty and fifty per cent.; while under the new provisions of the constitution, and due to the increased interest aroused by the standardization and tractor contest problems, a still greater increase is looked for in the present year.

The following officers were elected for the ensuing year:

President—L. W. Chase, Lincoln, Neb.

First Vice-president—E. A. Rumely, La Porte, Ind.

Second Vice-president—J. A. King, Chicago, Ill.

Secretary—I. W. Dickerson, Urbana, Ill.

Treasurer—J. L. Mowry, St. Paul, Minn.

Councilor—J. B. Davidson, Ames, Ia.

I. W. Dickerson,
Secretary

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

The 464th regular meeting of the society was held at 4:30 P.M., December 17, 1912, in Room 43 of the New National Museum, the president, Mr. Stetson, in the chair.

Professor C. V. Piper read a paper on the Filipinos and the problem of their government, beginning by a general résumé of the insular conditions and various peoples dwelling there, of whom he said the Negritoes, now found mainly in four islands but once in nearly all, are generally regarded as the original inhabitants, the Igorrotes and other wild tribes being the next to arrive, the Filipinos next, perhaps about A.D. 500, and the Moros last, not long before the time of the Spanish occupation. At some length he described the Filipino characteristics, distinguishing between the small educated minority and the majority of ignorant laborers. His conclusion was that immediate independence would be injurious, but that our government should establish some limit in the future defined by conditions of education of the majority of the race. The most remarkable thing we are doing there, he said, is the attempt, for the first time in history, to educate an inferior people *en masse*. The Asiatic European colonies have little faith in its success, but are influenced by it and our general policy.

Dr. Riley B. Moore read a paper on his observations in St. Lawrence Island, one hundred by thirty miles of treeless swamp and tundra, inhabited by some two hundred and fifty people, the débris of five different tribes in the Bering Sea. Some of these resemble Sioux Indians: others are typical Mongolians, with all intervening kinds. In summer they have a profusion of birds and fish to feed on; but in other seasons their food is whale-meat, seal-meat and walrus-meat. They live with little ventilation and many skin diseases. Tuberculosis also is very common. The death rate has long exceeded the birth rate.

W. H. Babcock,
Secretary

SCIENCE

FRIDAY, FEBRUARY 14, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

PLEISTOCENE GEOLOGY OF NEW YORK STATE.[1] I

INTRODUCTION

THE primacy of New York among the states in population, wealth, manufacture and commerce is based on its physical characters—geologic structure, physiographic relief and geographic relations. The state has the greatest range and perfection in its stratigraphic series and the greatest variety in physiographic features. In scenery other states may possess single features of surpassing grandeur and beauty, like the Colorado Grand Canyon, Yosemite Valley, Crater Lake, the mountains of the Cordillera or the snow-capped volcanic cones of the northwest, but for abundance and variety of beautiful scenery of educational value New York may claim first place. In the variety and excellence of Pleistocene phenomena the state probably excels any other equal area of the earth's surface. This is due to the varied and unusual physiography combined with a favoring attitude of the area in relation to the continental glacier. The features of special excellence occur largely in the western part of the state. These are the series of more than twenty parallel, north-sloping valleys which hold the unique series of twelve so-called Finger lakes; the remarkable succession of glacial lakes in the Ontario drainage area; the conspicuous, abandoned channels of the rivers that drained those lakes; the surpassing display of drumlins, of kames and eskers; the fine series of mo-

[1] Annual address of the president of the Geological Society of America, read on December 28, 1912. The numerous maps which illustrated this address are here omitted.

raines, and the large number of Postglacial ravines.

The purpose of this writing is to utilize this remarkable display of Pleistocene phenomena in illustration of the glacial history and in brief discussion of some problems in the philosophy of glaciation.

MULTIPLE GLACIATION

The accepted facts of multiple glaciation in the Mississippi basin coupled with proofs of Prewisconsin drift in Pennsylvania and New Jersey and on Long Island, with accumulating evidences in New England, demands the theoretical acceptance of at least dual glaciation for New York state. But the positive proof, in the field, of a Prewisconsin ice sheet has not been found. In several localities the deeper till is so unlike the upper till that it strongly suggests a separate origin. Some singular topographic features are not satisfactorily explained without appeal to the earlier ice invasions. The Rutland Hollow, east of Watertown, is an example. Many erosion features, specially in the St. Lawrence district, seem inconsonant with the work of the latest ice.[2] However, we have found no example of interglacial or warm-climate deposits interbedded in the till. Such should be expected and sought, but at present we can only say that multiple glaciation in New York, at least north of Long Island, is quite certain in our philosophy but that it remains unproven in observation.

Although our glacial phenomena in New York are doubtless not the effects of merely the latest or Laurentian ice sheet, the latter so strongly dominates that for purpose of this writing it is impracticable to attempt discrimination, and unless specially noted it will be understood that reference is to the latest, or Wisconsin, glaciation.

[2] For discussion of this subject see N. Y. State Museum Bulletins, No. 145, pp. 164–172; No. 160, pp. 17–18.

LAURENTIAN (LABRADORIAN) ICE BODY

The reach or extent of the latest ice sheet has long been known in a general way through the early work of Upham, Lewis and Wright in tracing the terminal moraine. In later years the stretches of the terminal moraine which lie in New York have been reexamined, on Long Island by Woodworth and Fuller and Veatch, and in Cattaraugus county by Leverett. There are two small areas in the state which the ice sheet did not cover, the south side of Long Island and the district partly enclosed by the northward bend of the Alleghany River.

At its maximum the ice sheet covered the highest points in the state, the Adirondack (5,344 feet) and the Catskill (4,205 feet) mountains. Judging from the Antarctic and Greenland ice caps the surface of the Laurentian shield was a low dome of fairly uniform curvature, uninfluenced by the irregularities of the submerged land surface. Our only means of estimating the thickness of the ice cap is by assuming a gradient of the surface slope, as suggested by observations on the existing polar ice fields. Such data, however, can be safely used only in a suggestive way when applied to the Laurentian ice shield, because the difference in latitude must be an important factor. The border of our ice field, in latitude 41 to 44 degrees, was subjected to so much greater solar radiation and consequent higher temperatures, with heavy precipitation and rains, that it must have had increased plasticity and resultant mobility, giving the surface slope diminished gradient. But on the other hand the snow supply over the central area or alimentation ground of the ice field must have been greater than over the polar fields, which might give greater depth and steeper gradients toward the interior of the field. The anticyclonic winds over the ice cap, re-

cently emphasized by Hobbs, would brush the snow toward the borders of the field and so tend to reduce the surface slope of the interior.

Shackelton found that the great outlet glacier in Antarctica, named the Beardmore, had a rise of 80 feet per mile for 100 miles, with declining rate inland, attaining about 11,000 feet in 275 miles, or 40 feet per mile for the entire distance. If we assume a slope of 60 feet per mile for the glacier surface over western New York it gives an altitude of over 9,000 feet on the area of Lake Ontario, the margin of the ice sheet lying at near 2,000 feet altitude. Over central New York (district of Oneida Lake) the altitude would be about the same; and if to this we add 30 feet per mile to the middle of the Adirondacks it gives 3,000 feet more, or over 12,000 feet altitude. If we assume 40 feet per mile on the Hudson-Champlain meridian it gives 12,500 feet of ice on the Canadian boundary. Thirty feet per mile gives over 9,000 feet of ice. These figures may be somewhat excessive, but they at least prove the fact of a great thickness of solid water piled over the state. The effect of such weight will be noted later.

The ice mass had a spreading or radial flow, as a plastic body, due to its own weight. The prevailing direction over New York was southwestward, except that in the lower Hudson Valley the flow was southward; conforming to the valley. The waning or thinning ice sheet was deflected by the larger topographic relief, and when the ice mass resting over the Ontario basin ceased to be impelled by thrust from the northeast it developed a spreading flow, radiating from the area now occupied by Lake Ontario. This is well shown by the orientation of the drumlins in the Ontario basin. A good illustration of valley diversion is shown in the maps, depicting how the Hudson lobe and the Ontario lobe pushed into the Mohawk Valley from opposite directions, impounding glacial waters between them. As the direction of flow near the margin of the ice sheet must incline to right angle, or normal to the ice front, the direction of latest movement in any district can be approximately known if the ice limit is determined. The series of maps accompanying this writing show several stages in the waning and disappearance of the ice and suggest the direction of flow at different positions.

The set of maps gives fifteen positions of the ice front during its recession across the state. A larger number could be depicted, but only those have been selected which have some significance in the lake and drainage history. The criteria used in locating the ice front positions are the moraines and the ice-border river channels, the latter correlating with lake levels and shore features.

The recession of the ice front was certainly not steady or continuous, but must have had considerable oscillation, readvances and reretreats. The heavier belts of moraine and the lines of long-lived ice-border drainage probably represent readvanced positions.

The length of time represented by the passage of the ice front across New York is unknown, but is certainly scores of thousands of years. Probably 100,000 years is not too long. We may not judge the rate of waning by the present behavior of the ice fronts in Greenland and Antarctica, as the climatic factors due to difference of latitude must have been effective. If the oscillations of the ice front were due to any irregular or nonperiodic variations of climate, then we can have no idea of the time involved either in the advance or the waning of the ice sheet. And the only periodicity in climatic factors now recognized

that seems adequate is the precession of the equinoxes, having a variable but average period of about 21,000 years. *Taylor* has studied the Cincinnati-Mackinac moraine series from this viewpoint, and concludes that the fifteen rather equally spaced moraines represent 75,000 to 150,000 years, using the minimum length of the precession period.[3] The eight or ten morainic belts which we now recognize in western New York may correlate with that many on the Cincinnati-Mackinac meridian, but the recession of the ice front on the Hudson-Champlain meridian probably represents a much longer time than the Ohio-Michigan series.

If the changes in geologic climates be due to variation in solar radiation it is conceivable that some minor secularity might be responsible for the oscillations of the ice front. Variation in the amount of carbon dioxide content of the atmosphere can more reasonably be invoked to explain the larger and more irregular changes in ancient climates than for the shorter and more regular changes that caused the ice front oscillations. The same is true of continental elevation as a cause of colder climate.

GEOLOGIC EFFECTS OF THE ICE SHEET

Erosional work.—The subject relating to glaciers that has been the cause of the greatest difference of opinion is the erosive power or destructional work. The writer will here not discuss seriously glacial erosion in general, but only so far as it applies to New York.[4]

That mountain glaciers abrade their valleys and by moderate erosional work change the V-shape to the U-shape has long been apparent. The destructive work at the head of the glacier in production of cirques is fully recognized, although this is largely atmospheric effect. All argument for deep erosion by glaciers based on the abrasional or plucking action of mountain or stream glaciers fails when applied to New York, as there were no effective mountain glaciers in New England and New York, at least not during the waning of the Laurentian ice body. The ice disappeared from the more elevated tracts, while lingering in the lowlands. Whatever the erosive power attributed to mountain glaciers of Norway or New Zealand, it can not be invoked here, as New York had no such glaciers. We have to consider only the work of a continental glacier. Whatever destructive effects an ice cap may have under its central or subcentral mass, it has long been admitted that it is not a vigorous erosive agent in its border zone or dissipating belt. The district in New York, the Finger Lake area, which has been used in illustration of glacial valley erosion, was always in merely the outer zone, or that of predominant deposition by the Laurentian glacier. All students of New York geology practically agree on the lack of vigorous ice erosion over all the rest of the state. Those who have worked in the Adirondacks and in the Champlain and St. Lawrence valleys have noted the proofs of a weak erosion.[5] It has been shown by Gilbert and the writer that erosion was weak on the Ontario lowland of western New York. The claim for deep erosion has been only for the valleys of the Finger lakes, specially Cayuga and Seneca, the claim based chiefly on anomalous topographic features.

The advocates of glacial deepening of the valleys appeal either to vigorous currents at the bottom of the ice sheet or to the tongue-like lobations of the ice front, to deeply gouge the bottoms of the valleys so as to produce hanging side valleys and

[3] *Journal of Geology*, Vol. 5, pp. 421–465, 1897.

[4] For the argument in general see *Bull. Geol. Soc. Am.*, Vol. 16, pp. 13–74, 1905.

[5] See N. Y. State Museum Bull. 145, pp. 147, 171–172, 1910.

"oversteepening" of the lower slopes of the main valleys. The existence of effective basal currents in the region under consideration seems highly improbable. The general land slope was opposed to the ice flow, that is, the ice was moving on an upslope. The lower or basal ice was very heavily burdened with rock rubbish and would naturally serve as the bridge over which the upper ice traveled, partly by shearing and partly by superior plasticity. But if for argument we grant the existence of effective bottom currents, then we are forced to concede that under the conditions of great vertical pressure, with the movement on an up-slope in soft shale rocks, the erosion would have to be by abrasion and not by plucking. At its intensest, abrasion must be a slow and a self-checking process. Long ago Russell emphasized the fact that plasticity of the ice is reduced in proportion to its burden of drift. Admitting this, it follows that an excess of rock stuff in the basal ice, the inevitable result of heavy erosion, would produce stagnation. Moreover, the excessive product of grinding would serve as a buffer to protect the bed rock, just as a stream full-loaded with detritus ceases to erode.

If the lobations or valley tongues of the ice margin had any erosive effect comparable to mountain glaciers, such work should have been greatest south of the land divide, or where gravity directly assisted the flow. But the conspicuous lack of erosive work on the uplands and south of the divide is frankly admitted. In description of the area covering the eight quadrangles of the Watkins-Ithaca-Elmira-Owego district, in the U. S. Geological Survey Folio 169, Professor Tarr, who was the leading advocate of glacial erosion of the Finger Lake valleys, wrote:

In harmony with this evidence of slight erosion is the fact that the mature upland divide areas have suffered notable modification only by deposition and not at all, so far as can be seen, by ice erosion (page 16).

In the southern half of the area glacial erosion was not sufficient to remove the products of preglacial decay from the hills, nor, so far as any evidence goes to show, to modify perceptibly the topography even of the valleys (page 31).

North of the divide the lobations of the ice front were pushed up the valleys by the pressure of the ice in their rear, and were so heavily loaded with drift that they were not eroding, but depositing. The fact of superload of drift is clearly shown by Tarr's map of the surficial geology. South of the divide morainal drift is almost entirely lacking in the south-leading valleys and only scantily represented in the larger east and west Susquehanna and Chemung valleys. Tarr says:

On the upland, south of the area of the recessional moraines, little moraine material is found and no definite system has been worked out.

The complex of moraines in the northern part of the Watkins Glen quadrangle and the northwestern part of the Catatonk quadrangle, contrasted with the general absence of moraines in the southern half of the area, forms one of the most striking features of the Quaternary geology (page 17).

The heavy morainal drift in the valleys north of the divide was not derived from erosion of those valleys, but was the accumulated rock rubbish acquired by the lower part of the ice sheet during its entire journey across the state. When the ice was thick enough to override the divide and flow south it was the superficial, drift-free ice that passed across, while the lower, drift-loaded and relatively stagnant ice reposed in the Ontario basin and its valleys, serving as the bridge that was overriden by the clearer and more plastic superficial layers. In evidence of this is the relative absence of drift south of the divide, and the almost entire absence of crystalline rocks or far-traveled material. Quoting Tarr:

In the uplands south of the recessional moraines *foreign fragments are much more rare, and in some parts of the uplands a careful search is required to find even a small pebble of crystalline* rock, while bowlders are practically absent (page 16).

To whatever extent the ice in the margin of the snow field was produced by the centrifugal, anticyclonic winds from the interior of the ice cap, as suggested by Hobbs from study of the existing continental glaciers,[6] it also favored lack of drift in the periphery of the ice body. With the waning and thinning of the ice cap the drift-loaded lower ice was finally uncovered so as to constitute the marginal belt, and was then subjected to thrust or push from the thicker body on the north. At this stage the heavy moraine deposits were made in the valleys, producing the present drainage divide, and the lobations of the ice front built the crescentic lateral-terminal ridges north of the divide. At a later stage of the waning, when the required factors were properly combined and balanced, the drumlins were constructed on the lowlands, northward.

Many facts are cited by Tarr showing the impotency of the latest ice sheet, and he finally admitted that the

Wisconsin ice sheet failed to notably modify the topography in the greater part of this area (page 16).

This would seem to terminate the debate about glacial erosion in the Finger Lake district. But it does not, as the responsibility for the anomalous topography is shifted back to the Prewisconsin glaciers.

This carries with it the necessity of believing in 1,500 feet of vertical erosion in the Seneca Valley by the continued ice work of at least two periods of glacial occupation, separated by an interval of gorge cutting several times as long as the postglacial interval (page 16).

The statement is warranted, therefore, that these valleys have been profoundly modified by glacial erosion, both by deepening and broadening (page 30).

But here, as in the process of glacial stream erosion, the bulk of the work was done by an earlier ice advance (page 31).

It is admitted that ice sheets may have some individuality and that successive sheets on the same territory may have somewhat different behavior and produce different effects, due to differences in the climatic, topographic and drift factors. But it does not seem reasonable that one ice sheet could deepen Seneca Valley 1,500 feet, while its successor did practically no eroding at all. If the Prewisconsin ice sheet had such remarkable excavating power it should have produced conspicuous erosional effects elsewhere than in the valleys, and specially in the southern part of the state, and should have piled heavy "old drift" deposits beyond the reach of the Wisconsin ice.

The drift burden of the Laurentian ice sheet is represented not merely by the mass of the moraines and the volume of detritus carried away by the glacial drainage, but also by the enormous bulk of drift built into the drumlins. Even if the drumlins were partly constructed by the earlier ice sheet they can not, because of their location, represent any product of deep erosion of the sections of Seneca and Cayuga valleys in question. There are no heavy moraine deposits south of the Valley-Heads moraine, for the terminal moraine is not massive, and the ancient drift in Pennsylvania and New Jersey is not excessive in volume. The only other disposal of the great volume of débris that should have been produced by deepening of the valleys 1,500 feet must have been by outwash of the glacial drainage. But when the valley-train and outwash deposits attributed to the latest ice are considered there is no

[6] "Characteristics of Existing Glaciers," 1911.

very large volume left to represent any earlier drainage.

The entire argument for deep ice erosion in the Finger Lake region is based on physiographic features, hanging valleys and "oversteepened" valley walls. The writer believes that sufficient attention has not been given to the effects of Prepleistocene drainage in connection with the climatic, topographic and diastrophic factors. The high elevation of the northern part of the continent in Tertiary time seems to be a fact, and accompanied by warm climate. If necessary to explain phenomena we may assume effective vertical movements in our region. The Tertiary was certainly a time of vigorous drainage and remarkable valley-cutting in northern lands. When the fiord valleys were making in other lands what was doing here? Undoubtedly our rivers were also active, and the deep valleys of central New York are one result.

At the last Baltimore meeting of the society the writer exhibited a series of maps suggesting the drainage evolution in New York.[7] The high "Hung-up" valleys with northeast by southwest direction, and mostly without present streams, seem to be an inheritance from the primitive drainage on the new land surface. The drainage lines of the upper tributaries to the Delaware and Susquehanna rivers preserve their original direction. During some Prepleistocene time the development of subsequent valleys along the strike of the thick and weak Ontario strata resulted in a great east and west valley, carrying a great trunk stream, the hypothetical Ontarian River. Into this valley was drawn from the south, as obsequent streams, all the drainage of western and central New York and the adjacent territory of northern Pennsylvania. The Susquehanna River turned northward at Elmira and occupied the Seneca Valley, which probably accounts for the excessive depth of the valley, a drilling at Watkins of 1,200 feet failing to reach rock. The Genesee River is the one stream which fully represents the Preglacial northward flow, having held to its northward direction clear across the state in spite of the tendency of glaciation to force it into southward flow. All the other drainage of south-central New York was forced to southward escape, mostly in tribute to the Susquehanna and through the new rock gorge at Towanda, Pa. A late and probably rapid land uplift, rejuvenating the obsequent drainage, will probably be found to satisfactorily account for the great depth and other anomalous features that have been used as arguments for deep glacial erosion in New York. Interglacial drainage may also be important in this work.

It will now be understood that when the earliest ice sheet invaded New York it found a topography unlike the present, a remarkable series of parallel, deep, open, north-sloping valleys that headed southward, the larger ones in Pennsylvania. The present divides in the valleys are due to the moraine fillings left by the ice. The deep canyon-like valleys were occupied by the glacier and some abrasion and smoothing of the walls was inevitable. But it should not be forgotten that the ice tongues in these valleys were not mountain glaciers, but merely lobations of a drift-burdened margin of an ice sheet moving on an upslope. Conceding some erosive power to the ice tongues in the valley, then instead of deepening the valleys and oversteepening the walls and so producing the present convex cross-profiles they should have cut the walls and widened the valleys and produced concave profiles. In the work of stream glaciers convexity of valley slope is succeeded by concavity. In final word, to

[7] Geol. Soc. Am., *Bull.*, Vol. 20, pp. 668–670, 1910.

a discussion already too long, in the opinion of the writer all the facts and philosophy of ice erosion argue against deep glacial erosion in the Finger Lake valleys.

One interesting product of glacial erosion is to be noted. These are some hills which have the form and attitude of true drumlins, but which are composed of soft shale, shaped into drumlin form. These rocdrumlins will be described later.

CONSTRUCTIONAL WORK.

Subglacial: Rocdrumlins.—The general drift sheet presents no special features meriting description at this time. The important subglacial deposits are the rocdrumlins. New York state probably has the best display of these interesting hills of any district in the world; in number, variety of form, variety in orientation, difference in composition and in the clear relationship to the correlating moraines.

Much space might be given to description of these singular and most beautiful hills, but they have already been quite fully described in a Bulletin of the State Museum.[8]

Possibly in other regions there may be drumlins produced by the ice overriding and reshaping moraines, but all the true drumlins observed in New York are certainly constructional in their origin. The New York moraines are mostly water-laid drift, especially north of the divide, the débris in the ice being largely grasped by the glacial drainage. If the drumlins were moraine accumulations they would have morainal composition and structure. On the contrary, they are very compact till, distinctly bedded with concentric structure. The best exhibition of the bedding is shown along the shore of Lake Ontario, between Sodus and Oswego, where the undercutting by the waves has dissected numerous drumlins from top to bottom and in different directions. Sand or gravel within the mass of the drumlin is of infrequent occurrence, though some of the drumlins between Clyde and Savannah hold considerable sand in their superficial layers. Many drumlins exhibit decided difference between the deeper and the superficial till, sometimes so pronounced as to suggest two epochs of construction.

[8] N. Y. State Museum Bull. 111, 1907.

Along the belt of outcrop of the soft Salina shales there are drumlins which have a shale base, and perhaps some with a shale core. Fifteen miles northwest of Syracuse and west of Baldwinsville the drumlin forms are entirely shale. The deeply weathered clay rock supplied to the ice sheet a plastic material similar in its behavior to the ground moraine. These hills are not true drumlins. They are wholly erosional in origin, as indeed are the true drumlins in their shaping. We have called them rocdrumlins, using the Celtic prefix. It is possible that similar forms will be found in the Champlain-Hudson Valley, shaped out of the softer Ordovician shales. The ice sheet does not appear to have had scraping force sufficient to shape into the drumlin curve any rock hills of harder materials than soft shale, though bosses of crystalline rocks in the St. Lawrence Valley and other districts of long-continued abrasion are rounded and smoothed on the struck sides.

The mechanics of drumlin construction is a complex problem. The required cooperation and balancing of several dynamic factors make the drumlins exceptional features even in the glaciated territory. The more important constructional factors appear to be: (1) An excessive amount of drift; (2) the drift of clayey or adhesive and plastic material; (3) such thickness of marginal ice and with such relation to the rearward ice body that the whole depth of

ice accepts a thrustal movement, producing a sliding motion of the ice in ground-contact; (4) such temperature or physical condition as to allow plasticity and some differential motion within the ice, essential for the overriding of the growing obstruction instead of its removal. Here is found a singular balancing of two opposing factors, rigidity and plasticity; rigidity holding the ice mass, as a whole, to its thrustal motion, while at the same time bands or currents within the ice sheet have unequal motion, permitting the curving or arching flow over the growing hill of drift. The drumlin-making process appears to be a plastering-on and a rubbing-down, depending on the condition of more friction between clay and clay than between clay and ice. The resulting form of the growing obstruction is that which offers the greatest resistance to removal, or the least resistance to the passage of the ice over it. The molding action of the ice sheet is well shown by the minor ridges in some districts, the secondary and tertiary inferior ridges lying on the flanks of or between the primary ridges suggest the wood-molding struck in the planing mill.

The complex of forces and conditions necessary for drumlin construction explains their peculiar distribution, orientation and form. In the western half of New York the rich display of drumlins (nearly a thousand ridges being shown by the contours on the Palmyra sheet alone) is practically limited to the territory north of the divide, where the drift was profuse and the thinning ice was pushing on an upslope. In the Ontario basin their attitude or direction of the major axis is radial to the middle of the basin, varying from due east to southwest. In the Erie basin a group about Chautauqua Lake points southeast, while in the Mohawk valley north of Richfield Springs a group has westward pointing. In the Champlain and Hudson valleys the drumlins point southward. In the St. Lawrence Valley they show the latest and spreading flow. Everywhere they show the later ice-flow direction.

The most typical drumlin form, that which seems to express the most vigorous action and effective balancing of the several factors, is an elongated oval with steep convex side slopes, and these are found in the middle of the drumlin belt. New York exhibits all possible variations from this form. The shorter ridges, sometimes approaching dome-shape, but usually with some irregularity or lack of symmetry, are found at the north or proximate side of the drumlin belt, which suggests that the broad form is the product of less perfect work. The much elongated and attenuated ridges lie at the south or ultimate side of the belt and indicate the more uniform or rigid flow of the ice sheet with deficiency of drift.

In the western end of the state the till sheet over large areas has been rubbed into a fluted or washboard form on a large scale, but with low relief. It is inferred that this drumlinized surface with ribs one fourth to one half mile wide represents the work of thick ice, having great weight and vertical pressure, with diminished plasticity and carrying only a moderate load of drift. The direction of the flutings, southwestward, is the direction of flow of the maximum ice body.

In central New York we have been able to definitely correlate the drumlin belt with its synchronous moraine; to determine the position of the ice front during the drumlin-making episode. On the meridian of Seneca and Cayuga lakes the drumlins of the north side of the belt are more scattering and irregular in form. In the middle of the belt they are close-set, typical, elongated ovals. Southward they become close-set ridges with secondary flutings; while at

the south edge of the belt they are slender ridges and flutings, too attenuated to be represented by the twenty-feet contours of the topographic sheets. It would require at least five-feet contours to show the frontal drumlinized surface. Two miles in front of the most southerly ridges indicated on the Geneva sheet lies a weak but definite moraine. It is weak because the ice had plastered its load of drift into the drumlins.

From the relation of the ice front to the glacial waters and other data it has been roughly estimated that the thickness of the ice over the middle of the drumlin belt was about 900 feet, or more than 700 feet over the tops of the highest drumlins.

Marginal: Moraines.—The only map published to the present time that shows moraines in detail is that by Tarr in the Watkins Glen-Catatonk folio (No. 169), which is accompanied by good description. This map, Surficial Geology, covers eight quadrangles of the south-central portion of the state and includes the upper (southern) ends of the Seneca and Cayuga valleys. Except a few fragmentary moraines in the east and west stretch of the Susquehanna and Chemung valleys there are almost no moraines south of the divide, as already noted in this writing. The lines of drift massing show decided lobation of the ice in the valleys north of the divide and conformity to the land surface. The plastic ice was here flowing on its own deposits and had no erosive power. Probably the only moraines in the state that can properly be called "lateral" lie in these valleys.

In the west half of the state the heavier or more conspicuous morainic belts have been approximately located though little precise mapping has been attempted. The most recent and definite is by Leverett,[9] and a sketch map, Fig. 11, page 15, in the Folio 169. These morainic belts clearly show the larger lobation of the waning ice sheet in the Ontario and Erie basins.

[9] U. S. Geol. Surv., Monograph XLI., 1902.

In the east half of the state the moraines have been located in only few places, excepting the terminal moraine. In the Hudson and Champlain valleys Woodworth has recognized some fragments and ice-contacts. This difference in moraine development between the two parts of the state is due to the difference in the gross topography. A glance at the map shows that on the Hudson-Champlain meridian the distance covered by the receding ice front is greater than in the Ontario basin, so spreading the drift over more area. The rocks in the east part of the state are more resistant to erosion, due to kind and structure. The Hudson ice lobe and its successor in the Champlain Valley were always faced by ocean waters and the terminal drift in the bottom section of the great valley was mostly scattered and buried under the water deposits. On the high grounds east and west of the marine inlet the surfaces are so rough, or even mountainous, that the moraine deposits lack continuity and volume. It will be very difficult to trace morainic belts across the Hudson-Champlain Valley with certainty, though it is important to know the lines of the receding ice front.

WORK OF GLACIAL WATERS

Erosional Work of Streams. Normal Drainage.—It is apparent that the flow of glacial waters freely away from the ice could occur only south of the divide, and as the present divide was established by morainal filling and lies north of the preglacial divide much of the southward flow was drainage of ice-dammed waters, and that some of the present south-leading channels were cut by the glacial waters. The preglacial flow of the main streams

was northward, but the tributaries had various directions. The glacial drainage took advantage of the favoring valleys and connected them into sequence of southward flow. Tarr thought that the work of stream diversion and of channel erosion was mainly Prewisconsin, for the district described in the Folio 169 (page 30). He specially cites the outlet of Cayuga Lake, the gorge of Tioughnioga creek and the gorge of Chemung River behind Hawes hill, west of Elmira. The copious waters from the waning Laurentian ice sheet were supplied with such volume of detritus that they were largely aggrading agents. It is possible that the south-leading valleys were mostly established by Prewisconsin glacial drainage and that the work of the latest glacial floods was chiefly transportative. In the eastern half of the state the glacial outflow was freely into the Susquehanna and Delaware escape or into the Hudson-Champlain marine inlet, so there was no necessity for cutting new channels.

The heaviest normal drainage was that in south-central New York, concentrated in the Susquehanna, which cut the gorge south of Sayre, Pa., and the river which drained Lake Iroquois through the Mohawk Valley, the Iromohawk. This great river was the predecessor of the St. Lawrence, which it probably exceeded in volume, as it carried not only the outflow of the glacial Great Lakes, but the copious waters from the glacial melting.

Subglacial Drainage.—This class of glacial streams has been noted chiefly in relation to eskers, which fall under another head in this writing. It is not likely that all eskers were laid down in the beds of streams actually beneath, or in tunnels under, the ice sheet, though some probably were. Probably most subglacial or englacial streams were full loaded with detritus, and it is not likely that many streams beneath the ice margin were so free of drift or under such hydraulic pressure as to seriously erode their beds. However, a few peculiar channels, or "dead" creeks, have been noted which have such form and relations as to suggest erosional flow beneath the stagnant margin of the ice. One of these bayou-like channels is that of Dead creek, a tributary of Seneca River, lying southwest of Baldwinsville, and mapped on the Baldwinsville sheet.

Marginal Drainage.—This class of drainage phenomena included many of the most conspicuous and interesting features connected with the disappearance of the ice sheet, and they have been the subject of much work by the writer. The ice-border drainage channels are important as they locate ice-front positions and determine the altitude of the glacial lakes which they drained. They are humanly, or economically, important since they have graded the ways for many lines of communication or transportation. And they are specially valuable for geologic instruction since they are widely distributed and easily recognized products of long extinct agencies.

It is evident that stream flow along the ice margin could occur only where the land surface sloped toward the ice, and consequently only north of the divide. The remarkable physiography of the western half of the state favored the production of glacial lakes, which required outlet channels for the imprisoned waters.

The most notable series of ice-border drainage channels occur in five districts. (1) On the south slope of the Erie basin, where the ice-impounded waters in the north-sloping valleys escaped westward into the Erian glacial lakes. (2) Along the south slope of the Ontario basin the glacial waters found eastward escape toward the Mohawk-Hudson depression. (3) On the

Helderberg scarp, west of Albany, the waters of the Ontario and Mohawk basins escaped southward into the Hudson marine inlet. (4) In the district about Rome, at the east end of the Ontario basin, the waters from both the north and the west flowed along the sides of the ice lobe to reach the Mohawk Valley. (5) On the north and west sides of the Lowville highland the waters of the southwestern Adirondacks and the Black Valley forced their passage into Lake Iroquois.

The channels leading east through central New York, more conspicuously developed in the Syracuse district, were the predecessors of Niagara River in their function, the equal of Niagara in volume, and the rival of Niagara in cataract phenomena.

The successor of the Iromohawk and the immediate predecessor of the St. Lawrence was the outlet river of the second Lake Iroquois. This flowed across the north point of the Adirondack highland, at Covey Gulf, on the international boundary, with further flow in ice border channels along the slopes northwest of Plattsburg, on the Dannemora and Moors quadrangles.

CONSTRUCTIONAL WORK OF STREAMS.

Subglacial: Eskers.—The singular ridges of gravel, the laggard material in the beds of glacial streams, are well represented in the western part of the state and occur in the eastern part. Those lying in the northwestern section of the state have been studied, but the results are not published. Tarr describes in Folio 169 (pp. 22–23) several which lie in the Susquehanna drainage territory, and of large dimensions, and Carney recognizes nine on the Moravia quadrangle. Eskers may not occur on southward slopes where the glacial streams had steeper gradient and free flow, but in localities where the ice margin was comparatively stagnant and the drainage was sluggish.

The argument for subglacial origin of eskers finds some support in the New York examples. Tarr regards some of those in the Susquehanna district as certainly made by subglacial streams. An esker four miles east of Clayton was deposited about 350 feet beneath the level of Lake Iroquois, which was laving the ice front, and it is difficult to explain how it could have been constructed and its definite ridge-form preserved unless it was built directly on the ground. The same argument applies to the Ingoraham esker, north of Plattsburg.

Extraglacial: Kames.—Isolated mounds of sand or gravel are usually embryo deltas of glacial streams, and are commonly associated with eskers. By linear multiplication they not infrequently grade into esker ridges.

As kames are built at the debouchure of glacial streams, they indicate positions of the ice edge. Areas of kames lie in belts of recessional moraines, and indeed constitute a large part of the New York moraines. The glacial débris which was not spread as the till sheet or rubbed into drumlins was largely gathered up by the drainage and dropped as some form of water-laid drift.

In western New York a few large kame areas are not closely connected or clearly associated with any conspicuous moraine belt, but nevertheless must represent recessional moraine. It is possible that some smaller kames might have been built by land drainage into lateral glacial lakelets, but detritus from land erosion must commonly have produced deltas or sandplains and be easily recognized by form and association. The great development of kames, at least in western New York, is north of the divide, and they were built in the waters of glacial lakes. This association with standing waters is so pronounced

that it gives force to the idea that all typical kames are formed by streams debouching into water bodies, and sometimes by subglacial streams under hydraulic pressure. Streams debouching on the land would naturally produce either outwash plains or valley trains. The fact that basins or kettles, believed to be due to melting out of buried ice blocks, are usually abundant in areas of kames, seems to prove that the materials were laid down in standing water in close association with the stagnant ice margin, either on the ice or in hollows and valleys and reentrants in the ice.

Extraglacial: Outwash Plains.—These are the gravel and sand deposits spread out in front of the glacier by the outflow of the glacial streams and which can not be classed on the one hand as deltas or on the other as valley trains. Water-laid drift in facial contact or close association with the moraines and which can not be distinguished either as delta, kame or valley train, may safely be put in the indefinite class of outwash gravel plains. North of the divide where built in lakes they grade into deltas and kames. South of the divide they constitute most of the valley fillings, especially of the broader valleys which lay athwart the direction of ice flow.

A not uncommon feature of the gravel plains and one which shows the close relation to the glacier front, is the existence of ice-block kettles. The term "pitted plain" has been applied to the sand plains with numerous kettles. Another feature indicating their genesis is the preservation in some cases of the ice-contact slope. The outwash sand and gravel plains are more common in the southwest part of the state and in the Mohawk Valley. In the highlands the drainage was too free and vigorous. In the Champlain-Hudson Valley, lower levels, the sea-level waters distributed the glacial stream detritus, or it was buried under the deluge of sand contributed by the rivers since the ice disappeared. The very extensive sandplains on both sides of the Hudson River and Lake Champlain, for example, the Saratoga district, must be classed as marine deltas. But on the walls of the great valley above the marine plain Woodworth has noted ice-contact slopes of glacial outwash deposits. In the Susquehanna district Tarr found numerous plains of this class.

Extraglacial: Valley-Trains.—South of the divide, where the drainage had free escape, some detrital filling of the valleys is common and occasionally abundant. The high-level flood plains along the valley sides and the elevated deltas of lateral tributaries testify to the glacial floods and their burden of detritus. The deposit by glacial flow is of course intermingled with and in places buried under land stream detritus. The valley trains may be regarded as heading in outwash plains, and one might regard the glacial gravel deposits in the entire length of the valleys north of the terminal moraine as outwash. This view would restrict the true valley-trains to the fillings of valleys beyond the terminal moraine or reach of the ice sheet. In this latter view the valley-train drift would occur in New York only along the south side of Long Island, and in the small area south of the Alleghany River.

HERMAN L. FAIRCHILD
UNIVERSITY OF ROCHESTER

(*To be concluded*)

SCIENTIFIC NOTES AND NEWS

PROFESSOR WILLY WIEN, of Würzburg, will deliver at Columbia University, during the month of April, a series of lectures on recent developments in theoretical physics. Professor Wien received the Nobel prize in physics in 1911 and is well known for his researches in radiation and the electrical constitution of matter.

ON the occasion of the dedication of the new building of the Medical Department of the University of Georgia, on January 29, the LL.D. degree was conferred on Dr. William M. Polk, dean of Cornell University Medical College, and Dr. J. A. Witherspoon, president-elect of the American Medical Association.

DR. F. KÖRTE, who has been an important figure in the development of medicine in Germany, celebrated, on January 16, his ninety-fifth birthday.

KING CHRISTIAN has decorated Dr. V. Poulsen and Professor P. O. Pedersen with the medal of merit in gold on account of the honor they have brought to Denmark by their work in connection with wireless telegraphy and telegraphones.

M. B. BAILLAUD, director of the Paris Observatory, has been elected president, and M. H. Deslandres, director of the Meudon Observatory, vice-president, of the Paris Bureau des Longitudes for 1913.

DR. EBERHARD RIMANN, of the Technical Institute at Dresden, has been appointed director of the Geological Survey at Brazil in succession to Professor E. Hussac.

DR. E. M. KINDLE, since 1901 paleontologist in the U. S. Geological Survey, has accepted a similar position on the Geological Survey of Canada.

PROFESSOR H. E. CLIFFORD, who holds the McKay professorship of electrical engineering at Harvard University, will go in the second half-year to Annapolis, to organize graduate study in electrical engineering at the Naval Academy.

RICHARD M. HOLMAN, B.A. (Stanford, '07), senior instructor in botany, University of the Philippines, stationed from June, 1910, to June, 1912, at the College of Agriculture, Los Banos, Philippine Islands, is on leave of absence which extends to September, 1913. He is at present engaged in graduate study at Leipzig University.

PROFESSOR JAMES F. KEMP, of Columbia University, delivered a short course of lectures during the mouth of January, in the Faculty of Applied Science at McGill University, on "The Services of Geology to the Mining Industry."

DR. MARTIN FISCHER, of the University of Cincinnati, delivered the address at the third winter commencement of St. Louis University School of Medicine, January 30, on the subject, "Principles of Treatment of Edema and Nephritis."

DURING the week of January 13 to 18, Mr. Vilhjalmer Stefansson visited the University of North Dakota, at which he was a former student, and delivered a series of three lectures, as follows: January 13, "Five Years of Arctic Exploration"; January 14, "The Discovery of the Blond Eskimo"; January 15, "The Mind of Primitive Man." Later in the week he was a guest of the Icelandic Society, of which he is a member.

ON January 29, Dr. Joseph Barrell, professor of structural geology in Yale University, gave an illustrated lecture on "A Reconstruction of Connecticut's Geologic Past," under the auspices of the Yale chapter of Sigma Xi.

THE seventh of the present course of Harvey Society lectures will be given at the New York Academy of Medicine on February 15, by Dr. Theodore C. Janeway, of Columbia University, on "Nephritic Hypertension: Clinical and Experimental Studies."

THE Mutual Life Insurance Company is providing a series of lectures in New York City. The lecture of January 29 was delivered by Surgeon-General Rupert Blue, United States Public Health Service, who spoke on the bubonic plague and other contagious diseases.

PROFESSOR ISAIAH BOWMAN, of Yale University, delivered a lecture on "The Physiography of the Central Andes" before the Geological Department of Columbia University on January 28.

DR. ORVILLE HORWITZ, until his illness head of the department of Genito-Urinal Surgery in Jefferson Medical College, Philadelphia, died on January 28, aged fifty-five years.

DR. JAMES P. TUTTLE, fifty-six years of age, a practising surgeon and professor emeritus

of surgery in the Polyclinic Hospital, New York, died on January 30.

DR. O. T. WILLIAMS, lecturer on pharmacology and demonstrator of biochemistry in the University of Liverpool, has died at the age of thirty-five years.

PROFESSOR BINZ, who held the chair of pharmacology at Bonn, has died at the age of eighty years.

DR. F. TELLER, chief geologist at the "Geologische Reichsanstalt," Vienna, and member of the Vienna Academy of Sciences, died on January 10, in his sixty-first year.

DR. R. COLLETT, professor of zoology in the University of Christiania, has died at the age of seventy years.

DR. AUGUSTUS WITKOWSKI, professor of experimental physics in the University of Cracow, died on January 21, at fifty-eight years of age.

THE Archduke Rainer, the oldest member of the Imperial Austro-Hungarian family, who died on January 27, at eighty-five years of age, was actively interested in scientific and artistic activity. Foreign journals state that at the Vienna Academy of Sciences, of which he was curator, he never missed an important sitting, while the Austrian museums owed their development largely to his support.

IN the Senate of the United States on January 24 Mr. Cummins submitted the following resolution, which was considered and agreed to:

Resolved, That the Committee on Naval Affairs is hereby authorized and directed to investigate the affairs of the Naval Observatory and its relation to the American Ephemeris and Nautical Almanac; and, further, to inquire into the wisdom and propriety of placing the management of the Naval Observatory in the hands of scientists, without regard to their connection with the Navy of the United States.

Resolved further, That the said committee be directed to make report of the matters herein referred to it as soon as practicable.

THE Harriman Research Laboratory, which was established in New York City in 1910 and is maintained by Mrs. E. H. Harriman for the study of chemical problems connected with disease and owns and operates a building on the grounds of Roosevelt Hospital, has been incorporated.

A GOLD medal is offered by the American Laryngological Association for the best essay pertaining to laryngology or rhinology, preference being given to essays offering new suggestions of practical value arising from original work.

THE heirs of Herr Adolf Schwabacher, the Berlin banker, have established a foundation with 100,000 Marks, the income of which will be used to confer a prize in medicine every five years.

THE Astronomical Society of Mexico has decided, beginning from 1913, to offer a medal and diploma to any astronomer who discovers a comet. The medal will bear the name of "Carolina Herschel Medal."

THE ninth International Physiological Congress will be held at Groningen September 2–6 under the presidency of Professor H. J. Hamburger.

AT a special general meeting of the Royal Geographical Society, on January 15, the president, Lord Curzon, of Kedleston, moved the resolution: "That the society approve of the election of women as fellows," and it was carried by 130 votes to 51.

THE Jesup lectures on Heredity and Sex, by Dr. Thomas H. Morgan, professor of experimental zoology in Columbia University, are now being given in the lecture hall of the Museum of Natural History on Wednesday evenings at 8:15. The subjects are as follows:

February 5—"The Evolution of Sex."

February 12—"The Mechanism of Sex Determination."

February 19—"The Mendelian Principles of Heredity and their Bearing on Sex."

February 26—"Secondary Sexual Characters and their Relation to Darwin's Theory of Sexual Selection."

March 5—"The Effects of Castration and of Grafting on the Secondary Sexual Characters."

March 12—"Parthenogenesis and Sex."

March 19—"Inbreeding and Fertility."

March 26—"Special Cases of Sex Inheritance."

THE Norman W. Harris lectures of Northwestern University will this year be given by Dr. J. S. Ames, professor of physics in Johns Hopkins University. The series, comprising six lectures on the subject "The Constitution of Matter," is as follows:

February 24—"General Properties of Matter; Mass."

February 25—"Corpuscles and Atoms; Electrical Mass."

February 26—"Radioactivity; Gravitation."

February 27—"Radiation; Formation of Molecules; Elasticity."

February 28—"Properties of Metals; Thermionics."

March 1—"Models of Atoms; Conclusion."

WE learn from the *Journal* of the American Medical Association that on January 25 the American Society for Physicians' Study Travels, with national headquarters in Philadelphia and proposed branches throughout the United States, was formally organized at a meeting of prominent medical men at Philadelphia. Dr. James M. Anders was elected president and Dr. Albert Bernheim was chosen as secretary. The society proposes to send travel parties to foreign countries to report on the methods of leading medical men and scientists in Europe and South America. All physicians and scientific men qualified to become affiliated with the American Medical Association will be eligible for membership, and also associate and honorary members will be elected among the prominent medical and non-medical men of this and foreign countries.

ON February 3 the city of Providence passed a resolution accepting as a gift from the Audubon Society of Rhode Island the Manly-Hardy collection of North American birds and also as a gift from Mr. Horace F. Carpenter his collection of shells and minerals with a library descriptive of the same. The conditions of the gifts are that they shall be properly cared for and exhibited at the Park Museum within three years from date of acceptance. This means that the city will erect an addition to the museum almost as large as the present structure, equipped to exhibit the collections. The Manly-Hardy collection of North American birds, which has just been purchased by the Audubon Society of Rhode Island through subscriptions of its members and friends, is one of the most valuable private collections in existence and represents thirty-three consecutive years of work on the part of Mr. Hardy and his daughter, Mrs. Fannie Hardy Eckstorm. The collection is remarkable for its many specimens in breeding plumage, for some extinct and for numerous rare species. The Carpenter collection of shells and minerals represents about fifty years' work by Mr. Horace F. Carpenter, of Providence, and contains over three thousand species of shells, about five hundred different kinds of minerals and a library valued at over $2,000.

UNIVERSITY AND EDUCATIONAL NEWS

OHIO-MIAMI MEDICAL COLLEGE of the University of Cincinnati, has received $125,000 from a donor whose name is being withheld. An effort is being made to raise an endowment fund of $1,000,000.

DURING the past year three wills, involving property valued at $125,000, have been probated in favor of Knox College. About half of this amount becomes available immediately for the endowment of a professorship in one of the departments of science, while the remainder is held in trust during the lifetime of the widow of one of the testators.

MR. EUGENE MEYER and his wife, of New York, have given Cornell University $10,000 to endow a fellowship in memory of their son, Edgar J. Meyer, who graduated from Sibley College in the class of 1905 and whose life was lost by the sinking of the *Titanic*. The purpose of the fellowship is to encourage research in mechanical and electrical engineering.

THE *Journal* of the American Medical Association states that the College of Physicians and Surgeons of Chicago again passes under the control of the University of Illinois. This time it is a gift to the state institution partly

by the stockholders and partly by the alumni who purchased the stock not donated. The medical school has for several years held a contractual relationship with the University of Illinois, but that relationship was cancelled last spring. By the present transfer of all the stock, however, the medical school becomes an organic department of the university.

AN administrative committee of the faculty of the Johns Hopkins University has been appointed by the trustees to conduct the affairs of the university until a president is appointed. The chairman is Dr. William H. Welch, and the other members are Professors B. L. Gildersleeve, W. W. Willoughby, W. B. Clark, J. S. Ames, W. H. Howell and E. H. Griffin.

DR. J. W. W. STEPHENS has been appointed to the Sir Alfred Jones Chair of Tropical Medicine at Liverpool University, vacant through the resignation of Sir Ronald Ross, who has gone to live in London.

DISCUSSION AND CORRESPONDENCE

UNIVERSITY REGISTRATION STATISTICS

TO THE EDITOR OF SCIENCE: Unfortunately I was unable to see the proof of my contribution on "University Registration Statistics" to your issue of December 27, 1912, and, as a result, several errors have crept into the compilation which I desire to correct herewith.

Since the detailed figures for the *University of Nebraska* were not available at the time the article went to press, this institution was omitted from the table, consequently the refferences in the body of the article should be to twenty-eight instead of to twenty-nine institutions. The missing *Nebraska* figures are as follows: college, men, 464; college, women, 617; agriculture, 328; art, 19; forestry, 64; graduate school (non professional), 164; law, 222; medicine, 159; pedagogy, 148; pharmacy, 32; scientific schools, 376. After deducting the double registration of 110, it leaves a total fall registration on November 1, 1912, of 2,483. Of the 486 summer session students, 158 returned in the fall, giving a grand total of 2,811 students for the year.

The fall total at the *University of California* is 4,585, and not 4,741; and that of *Columbia* is 6,148 and not 6,153. The dagger after "extension and similar courses" under the *University of California* should be a plus sign. The grand totals at *Columbia* should read as follows: 1912: 9,002, 1911: 7,938, 1910: 7,411, 1909: 6,132, 1908: 5,677, 1903: 4,557.

The *Indiana* figures should read as follows: College, men, 709; college, women, 438; art, 45; graduate school, 70; journalism, 67; law, 108; medicine, 140; music, 58; pedagogy, 144; deduct double registration, 354; total, 1,423; summer session, 1,197; deduct 280 students who returned for work in fall; grand total, 2,340. Both *Indiana* and *Nebraska* should be omitted on page 889 among those institutions which have more than 1,400 students registered in the college.

The *Johns Hopkins* grand total for November 1, 1912, should read 944, and that for 1911, 1,120.

At the *University of Minnesota* the item of double registration should read 175, instead of 319, thus making the grand total 3,737. This grand total is exclusive of 1,326 students registered in "extension and similar courses," but this latter category of students was included in the figures for 1903 and for 1908–1911.

The grand total enrollment at the *University of Texas* for November 1, 1909, was 2,512, 1908: 2,410, 1903: 1,309.

	1912	1911	1904
Amherst	429	464	412
Brown (incl. graduate school)	934	933	988
Bryn Mawr (incl. graduate school)	444	440	441
College of the City of New York	1,109		
Dartmouth (incl. eng., med., grad. stud., and commerce)	1,294	1,385	926
Haverford	167	164	146
Lehigh	617	599	609
Massachusetts Institute of Technology	1,611	1,610	1.561
Mount Holyoke	748	771	674
Purdue	1,749	1,762	1,359
Smith	1,528	1,508	1,067
Vassar	1,044	1,055	979
Wellesley	1,424	1,483	1,050
Wesleyan	410	395	305
Williams	521	533	448

These changes in the table naturally necessitate certain changes in the body of the article on pages 887 and 889.

The enrollment as of November 1, 1912, of a number of colleges for men and women, and schools of technology is given in the preceding table.

RUDOLF TOMBO, JR.

COLUMBIA UNIVERSITY

BUILDING STONES AND CLAY PRODUCTS

IN the issue of SCIENCE for December 27, 1912, there appeared a review by George P. Merrill of "Building Stones and Clay Products" by Heinrich Ries. It seems to me that the criticisms thus set forth in the review are a trifle harsh and I would like to call attention to a few statements which seem inaccurate. The reviewer says:

> The portion devoted to stone contains nothing that is not to be found in other easily available works.

The fact that the work contains much information taken from American and foreign publications not even to be obtained in such a library as the Carnegie Library of Pittsburgh, would indicate that the information is not all *easily* available, while, in truth, a large part of it is practically *unavailable* to many of those who will make use of the book.

The second portion of the book, that devoted to clay products, he states "is little more than an abbreviation of what the author has already included in his well-known work, 'Clays, their Origin, Properties and Uses.'" In his work on clays, Dr. Ries devotes 42 pages to structural clay products, while in the book under criticism, 130 pages are given over to the subject. The new work contains 34 illustrations concerning clay products, only 6 of which were given in the book on clays. The section on clay products, if compared at all with the similar portion of the earlier book, is a decided *amplification* instead of an *abbreviation.*

All works of this character must be largely compilations and their value depends largely on the arrangement and the care in selecting the proper material from the wealth of publications at hand. Dr. Ries has apparently made good use of the available literature both American and foreign and has condensed it into a volume whose usefulness, for the class of readers for which it is intended, is, I believe, enhanced by such condensation.

HENRY LEIGHTON

UNIVERSITY OF PITTSBURGH

QUOTATIONS

CORRESPONDENCE BETWEEN THE PRESIDENT OF WESLEYAN UNIVERSITY AND THE PROFESSOR OF ECONOMICS AND SOCIAL SCIENCE[1]

My Dear Prof. Fisher:—The press, far and wide, contain articles relative to remarks in reference to the churches of the country, reputed to have been uttered by you in a recent address in Hartford. I desire to know whether or not you have been correctly reported. If you have been incorrectly reported, will you please give me an exact statement of what you did say?

Sincerely yours,

WILLIAM ARNOLD SHANKLIN

My Dear Dr. Shanklin:—In reply to your letter just received I would say that the report of my remarks before The Get Together Club in Hartford, last Wednesday evening, was substantially misleading. Partly by the omission of qualifying statements which made the setting and shaped the interpretation, partly by ascribing to me words and utterances which were not mine at all, and perhaps partly by the striking headlines which raised brief incidental remarks into the prominence of a principal theme, the original report, upon which apparently many newspaper conclusions and comments have been based was—as I should judge—decidedly unfair. This judgment of mine is confirmed in some degree at least, by the fact that the paper in which the report appeared was constrained by criticism in Hartford to offer me an opportunity to make corrections. There was, however, a large underlying element of truth in the report. I did not say that I would "throw Sunday wide open" or anything else of closely similar meaning. But I did say that I would allow very great freedom of Sunday observance, allowing a man pretty nearly anything that did not disturb the religious or other use of the day by others. I did say that I saw no religious inconsistency in

[1] The letters are all dated from Middletown on January 27.

a man's having an uproarious good time on Sunday; but I added that there should be no disturbance of the religious or other duties of the day by others. I did say that "I would," or that "I believe that I would" close up the churches temporarily, as an experiment. But I stated my reasons, with emphasis, because so many good, religious people have come to think of church going as a great part of the whole religious duty, and because, if there were no churches open for a time, these people would be constrained to turn to more important religious duties, of kindly service and the like. Just here I quoted the declaration of James as to the meaning of religion pure and undefiled.

The above will perhaps enable you to judge for yourself as to the degree of accuracy with which I was reported; but for a slight amplification of which I have just written, I am enclosing a copy of a letter which I sent in correction of the first report, and which was printed in the paper first reporting me, in its issue of last Saturday morning, January 25th.

Of course, not even all of what I am now placing at your disposal can make entirely clear my general attitude on Sunday observance; but it is probably quite enough to make you to see how and in what light I stood last Wednesday evening. And that, I am sure, is all of your present wants

Very sincerely yours,
WILLARD C. FISHER

My Dear Prof. Fisher:—Your letter of this date is just received. Even after consideration of your explanation of your position, I find it difficult to believe that any one with a just appreciation of the work which the churches have done and are doing for the religious and moral life of the community, could seriously propose the closing of the churches, even as a temporary experiment. I am constrained to the conviction that your attitude in the matter is so far out of harmony with the spirit of the college, which, though in no wise sectarian, is and always has been profoundly in sympathy with Christian churches, that your continuance in your present official position is undesirable for the college or for yourself. I feel therefore compelled to request you to offer your resignation.

Most sincerely yours,
WILLIAM ARNOLD SHANKLIN

My Dear Dr. Shanklin:—Of course I shall respond at once to your request for my resignation. Here it is. It is given cheerfully, I trust, and in full appreciation of the situation. I do not expect, I do not even undertake, to frame for myself a judgment as to what I might think the correct course for the college to take in such a case. But my judgment is not needed and it might be biased. I am, however, free enough from prejudice to see very clearly that a college with the history and the constituency and support of Wesleyan, is not exactly the place for a man who holds such views as mine, and who can not suppress them. I leave the college, therefore, without a trace of ill will toward anybody connected with it. Indeed I go with the warmest wishes for the institution to which I have given the twenty best years of my life.

Very cordially yours,
WILLARD C. FISHER

My Dear Prof. Fisher:—I have your favor, resigning from the faculty of Wesleyan University. I hereby release you from your duties, pending the presentation of your resignation to the board of trustees. I shall recommend that your salary be paid in full for the present academic year.

Appreciating your spirit of good will to the college, I am,

Most sincerely yours,
WILLIAM ARNOLD SHANKLIN

SCIENTIFIC BOOKS

Manual of Conchology. Vol. XXI. Achatinellidæ (Amastrinæ). By ALPHEUS HYATT and HENRY A. PILSBRY. Leptachatina by C. MONTAGUE COOKE. Philadelphia. 1911.

The "Manual of Conchology," founded many years ago by George W. Tryon, was designed to include descriptions of all the known living Mollusca. In Tryon's day it was essentially a compilation, but even so quite invaluable to conchologists. When Tryon died, and Dr. H. A. Pilsbry took his place, the character of the work changed, and the new volumes came more and more to represent exhaustive original research. The treatment of the Helicidæ, for example, put the whole subject on a new footing, and stands to-day as one of the great classics of malacology. Naturally the later parts have contained descriptions of fewer species than the early ones, the more elaborate treatment requiring more space;

hence the progress through families and genera has been much slower. On the other hand, considering the character of the work and the numerous illustrations, we may well marvel at the size of the yearly volumes, representing an amount of labor which few of us could undertake, even if possessing the necessary skill.

Professor Alpheus Hyatt died in 1902, leaving a quantity of unpublished manuscript on the Achatinellidæ, those remarkably varied and interesting snails of the Hawaiian Islands. Some years later these materials were turned over to Professor Pilsbry to be incorporated in the Achatinellidæ of the "Manual." The finished work is accordingly issued under the names of Hyatt and Pilsbry, although the greater part is by the junior author. The large genus *Leptachatina* (92 pp.) is by Mr. C. M. Cooke, of the Bishop Museum, Honolulu. The Achatinellidæ consist of two subfamilies, the arboreal Achatinellinæ, with usually light or brightly colored shells, and the mainly terrestrial Amastrinæ. The whole family is confined to the Hawaiian Islands, excepting the genus *Fernandezia* from the island of Juan Fernandez, which is located in the group provisionally, in the absence of any knowledge of the soft anatomy. The volume under review contains only the Amastrinæ; before the Achatinellinæ are described Dr. Pilsbry will himself visit the islands, and gain a first-hand knowledge of the subject.

The exhaustive and logical treatment, with the fine colored plates, enables us to gain a very good idea of the evolution and development of the Amastrinæ. The subfamily is to be divided into two very distinct tribes, which if given special names would be Leptachatinini and Amastrini. The first of these consists of oviparous forms, with shells closely resembling those of the circumpolar genus *Cochlicopa*. The second is to be divided into two series, both viviparous, but one elongate or Bulimoid, the other flattened or Helicoid. The flattened shells (three genera) were originally, when known, regarded as species of *Helix*, and the fact that they are indisputably Achatinellid shows how difficult it is to correctly place fossil land snails, known from the shells alone. One of the *Helix*-like genera was first (Ancey, 1889) named *Tropidoptera*, but was renamed *Pterodiscus* by Pilsbry on the ground that *Tropidoptera* was a homonym of the earlier Coleopterous *Tropidopterus*. In my opinion, *Tropidoptera* is a valid name,[1] the difference in the ending sufficing to prevent homonymy. I have long been familiar with the genera *Ancylus* (Mollusca) and *Ancyla* (Hymenoptera), and although using both names, have never found the slightest confusion to occur in my mind

The number of new Amastrine species described is large, indicating that the previous work on the Hawaiian mollusca, although voluminous, did not nearly exhaust the subject. The parts of the work most interesting to the general zoologist are the introductory chapter by Dr. Pilsbry, and the appendix compiled from Hyatt's manuscripts. According to Professor Hyatt the animals migrated from island to island in ancient times, and in some cases he even indicates the probable landing places of the immigrants and their subsequent migrations. Dr. Pilsbry, while fully agreeing with many of Hyatt's views, especially those on taxonomy, holds that while the snails did indeed migrate in various ways, it was on dry land. That is to say, the Hawaiian Archipelago was once a single large island, which presently divided into two, later into four, and finally reached its present condition. Good arguments are given in support of this hypothesis, and one can not help feeling that they would have convinced Professor Hyatt, had he lived to consider them and to go over all the evidence available at the present time. It is impossible in a review to adequately discuss this matter, but it is very evident that the whole subject is of the greatest interest to students of evolution, and when worked out from every point of view, may give us a definite idea of the time required for the evolution of species of various groups in the Hawaiian Islands. It is supposed that the large island Hawaii had only its most north-

[1] It is well to note that it has been omitted from the "Index Zoologicus."

ern part above water until just before the present stage in the development of the archipelago. This idea seems to receive support from the fact that the Achatinellidæ are almost confined to that part of the island, but it appears doubtful in view of the very large number of endemic Hymenoptera in Hawaii.

T. D. A. COCKERELL

Géologie du Bassin de Paris. Par M. PAUL LEMOINE. Paris. 1911. Pp. ii + 408; 137 figures; 9 maps.

Beginning with the classic "Description géologique des environs de Paris," by Cuvier and Brongniart, which reached a third edition as early as 1835, there have been a number of excellent general works on the geology of the Paris basin, that by Stanilas Meunier, first published in 1875, being perhaps the most used. Whatever the French do, they do well, and the Paris basin is such classic ground for the mesozoic and cenozoic geologist and paleontologist that the present work is of very great interest. That the book is well planned, well written and well illustrated is indeed but faint praise. M. Lemoine, who is vice-president of the Geological Society, has been working in the area for a number of years for the Geological Survey and is well equipped for the task of digesting the eight hundred odd memoirs treating of the area and combining their results with his own researches.

After three preliminary chapters devoted to an introduction for amateurs, and a historical, physiographic and tectonic discussion of the area, he plunges into the detailed geologic history of the basin, which commences with the Triassic. The Jurassic and Cretaceous of the Paris basin may be said to have furnished the standard for the world, as they have also so largely furnished the nomenclature, and these periods are treated at length. The very modern and altogether admirable work of the French paleontologists, particularly on the faunal facies and their correlation with particular sediments, is fully discussed and diagrammatically illustrated. Tertiary geology may be said to have been born in the Paris basin, even if Sir Charles Lyell was one of the wise men present at the birth, and here again the treatment is full and accurate. The Eocene in particular, because of the alternation of marine faunas with littoral, lacustrine and continental deposits containing land plants and terrestrial mammals, deserves to be and is rapidly becoming the world standard. The time is not far distant when the French étages will be used in all countries where men interest themselves in Tertiary history. Osborn has applied them with considerable success in his discussion of American mammal horizons and they lend themselves with equal readiness to discussions of the paleobotanical history of North America.

The book contains nine double-page maps and 137 text figures, every one of which is excellent, and will prove a most useful traveling companion for visiting geologists. The author is to be warmly congratulated, and it is to be hoped that American students will not only read the book, but try to imitate its method in their own geological writing.

EDWARD W. BERRY

JOHNS HOPKINS UNIVERSITY

SCIENTIFIC JOURNALS AND ARTICLES

THE opening (January) number of Vol. 14 of the *Transactions of the American Mathematical Society* contains the following papers:

F. N. Cole: "The triad systems of thirteen letters."

H. S. White: "Triple systems as transformations, and their paths among triads."

G. D. Birkhoff: "Proof of Poincaré's geometric theorem."

S. Lefschetz: "On the existence of loci with given singularities."

B. H. Camp: "Singular multiple integrals, with applications to series."

Oswald Veblen: "Decomposition of an n-space by a polyhedron."

C. N. Moore: "On convergence factors in double series and the double Fourier series."

Virgil Snyder: "Algebraic surfaces invariant under an infinite discontinuous group of birational transformations. Second paper."

N. J. Lennes: "Note on Van Vleck's non-measurable sets."

T. H. Gronwall: "Some asymptotic expressions in the theory of numbers."

H. H. Mitchell: "Determination of the finite quaternary linear groups."

L. S. Dederick: "On the character of a transformation in the neighborhood of a point where its Jacobian vanishes."

THE January number (Vol. 19, No. 4) of the *Bulletin of the American Mathematical Society* contains: Report of the October meeting of the society, by F. N. Cole; Report of the October meeting of the San Francisco Section, by T. M. Putnam; Report of the Cambridge meeting of the International Congress of Mathematicians, Sections II.–IV., by Virgil Snyder; Report of the Münster meeting of the German Mathematical Society, by Virgil Snyder; "Shorter Notices": Hulburt's Differential and Integral Calculus, by D. D. Leib; Voigt's Theorie der Zahlreihen und der Reihengleichungen, by R. D. Carmichael; "Notes"; and "New Publications."

THE February number of the *Bulletin* contains: Report of the sixth regular meeting of the Southwestern Section, by J. N. Van der Vries; "Some special boundary problems in the theory of harmonic functions," by T. H. Gronwall; "Note on Fermat's last theorem," by R. D. Carmichael; "Integral equations": review of Lalesco's Introduction à la Théorie des Equations intégrales and Heywood and Frechet's L'Equation de Fredholm et ses Applications à la Physique mathématique, by W. R. Longley; "An advance in theoretical mechanics": review of E. and F. Cosserat's Théorie des Corps déformables, by E. B. Wilson; "Shorter Notices": Fagnano's Opere matematiche, Heath's Method of Archimedes recently discovered by Heiberg, and Höfler's Didaktik des mathematischen Unterrichts, by D. E. Smith; Poincaré's Wert der Wissenschaft, by J. B. Shaw; V. and K. Kommerell's Spezielle Flächen und Theorie der Strahlensysteme, by E. B. Cowley; Horn's Einführung in die Theorie der partiellen Differentialgleichungen, by A. R. Crathorne; Forsyth's Lehrbuch der Differentialgleichungen and Poincaré's Calcul des Probabilités, by R. D. Carmichael; Lamb's Dynamical Theory of Sound, by E. B. Wilson; "Notes"; and "New Publications."

THE DIAGRAMS IN PROFESSOR THORNDIKE'S ADDRESS ON EDUCATIONAL DIAGNOSIS

THROUGH a misunderstanding the lettering was not given for the diagrams in Professor Thorndike's vice-presidential address before the American Association for the Advancement of Science, printed in SCIENCE for January 24. They are here reproduced with the inscriptions.

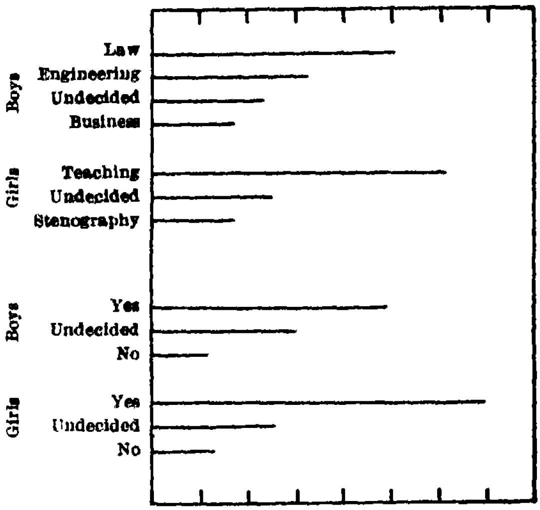

FIG. 4. The median expectation of length of stay in the New York City high schools, in the case of pupils who reported, at entrance to high schools, as shown at the left of the diagram, choice of occupation and intended length of stay.

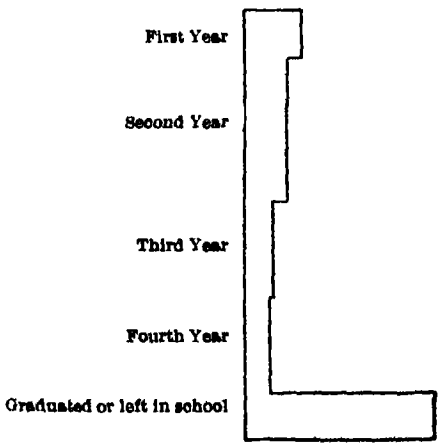

FIG. 5(*a*). The number of pupils, reporting themselves at entrance as expecting to complete the course, who leave in each successive year.

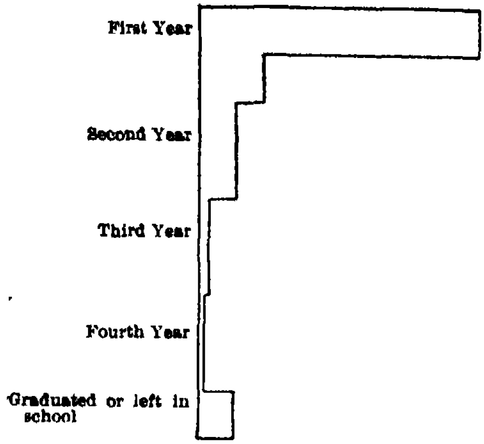

FIG. 5(*b*). The number of pupils, reporting themselves as expecting *not* to complete the course, who leave in each successive year.

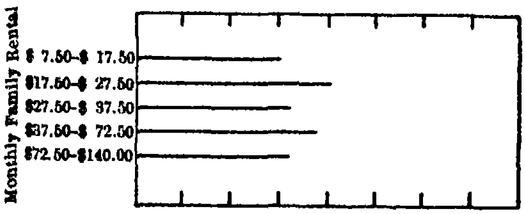

FIG. 6. The median expectation of length of stay in high school for pupils according to the family's monthly expense for rental.

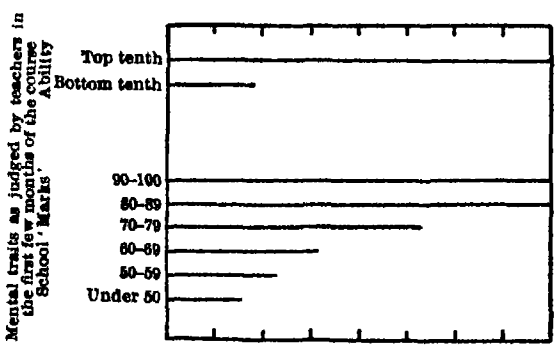

FIG. 7. The median expectation of length of stay in high school of pupils who during the first term were rated by their teachers as shown at the left of the diagram.

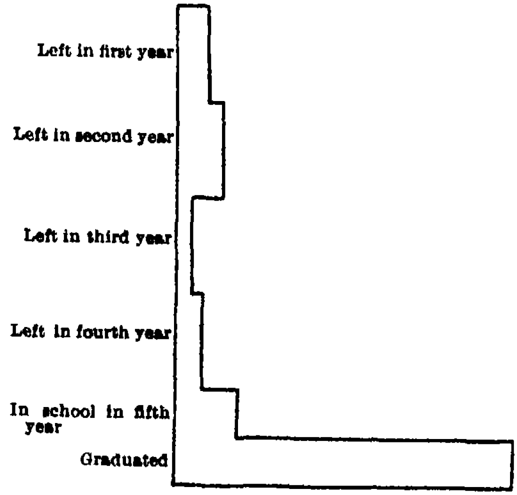

FIG. 8(*a*). The number of pupils, ranked in the top tenth for ability, who leave in each successive year.

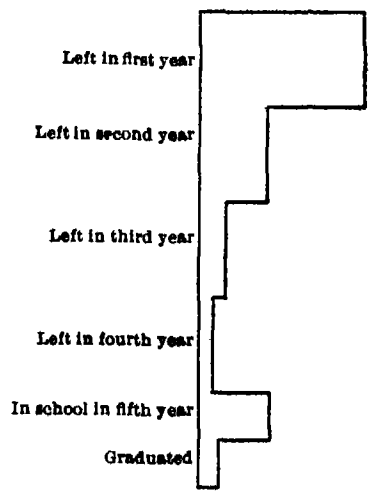

FIG. 8(*b*). The number of pupils, ranked in the bottom tenth for ability, who leave in each successive year.

SPECIAL ARTICLES

A WILD HOST-PLANT OF THE BOLL-WEEVIL IN ARIZONA

As cultivated cotton is the only plant thus far known to harbor the boll-weevil, the existence of another host-plant of these destructive insects may be worthy of notice. The plant

in question is not very well known, even from the botanical standpoint. It was described from Sonora by Asa Gray in 1855 as *Thurberia thespesioides*, and has also been identified with another Mexican species published in 1824 under the name *Ingenhouzia triloba*. But this generic name was preoccupied, an East Indian plant of another family having been named in honor of Ingenhousz in 1818. Nor is it certain that the Mexican *Ingenhouzia triloba* represented the same species that grows in Arizona. The flowers of the latter are white, while those of the Mexican species are described as yellow.

It is true that the characters supposed by Gray and Bentham to be of generic importance do not serve to distinguish *Thurberia* from *Gossypium*. The cells of the capsule show the same numbers, 3 or 4, as in many kinds of cotton, and some kinds of cotton imitate *Thurberia* in having a row of hairs on the inside of the carpel. But *Thurberia* offers more essential differences in the simple involucral bracts, the expanded corolla, and the absence of lint from the seeds, which are covered only with a thin, short fuzz. In view of these facts Gray's name may be retained.

Some attention has been given to *Thurberia* for the last three or four years in connection with the cotton-breeding work of the Department of Agriculture, because it seemed to be the nearest relative of the genus *Gossypium*. In external appearance and general behavior it is closely similar to some of the shrubby perennial types of cotton. The leaves are narrow and deeply divided like those of the so-called "okra" varieties of Upland cotton.

Until the present season the study of *Thurberia* has been limited to greenhouse and garden plants. The desirability of observing the habits and variations of the species in the wild state has been recognized, but all the localities where the plant was formerly known to exist were rather inaccessible. New localities on the slopes of the Santa Catalina Mountains not far from Tucson, Arizona, have been discovered recently by Professors Geo. F. Freeman and J. J. Thornber, of the University of Arizona, and one of these localities was visited a few weeks ago through the courtesy of Mr. Harold Bell Wright, who is a collaborator in the breeding work of the Bureau of Plant Industry. In a small canyon about two dozen large shrubby plants of *Thurberia* were found. Some of them might even be described as small trees, attaining a height of 10 feet, with hard woody trunks an inch in diameter. Six definite rings of annual growth are shown on one specimen.

The presence of punctures like those made by the boll-weevil on some of the seed capsules led to further search for the cause of the injury. At first only a few larvæ or pupæ could be found, embedded among the seeds of the nearly mature capsules, but finally a capsule containing an adult weevil was discovered by Mr. Wright. As all the plants had passed the flowering stage there was no means of learning whether the insect breeds in the floral buds as well as in the seed capsules, but it seems to be a habit of *Thurberia* to flower and fruit for only a short time in September and October. This habit of fruiting would not allow more than one or two broods of weevils to develop in each season.

Cotton is much more susceptible to weevil injury because it produces buds and bolls through a much longer period, thus providing facilities for breeding several generations of weevils. The fact that *Thurberia* is so much better adapted to escape serious injury may mean that it is the original host of the boll-weevil. Otherwise the infestation of *Thurberia* at Tucson must be explained by reference to prehistoric cotton cultures, which might have brought the weevil in from Mexico. The Pima Indians of Central Arizona cultivated an indigenous variety of cotton until a few decades ago, and the Hopi Indians of New Mexico still raise a little of their native cotton for ceremonial purposes. That the weevils in the Santa Catalina Mountains represent a recent importation from Texas seems altogether improbable.

As no cotton is now grown in the region of Tucson, the existence of weevils in the wild *Thurberia* is of no direct agricultural interest. But it is obviously desirable to know more of the habits and distribution of *Thurberia* in Arizona and adjacent states. A rapid exten-

sion of cotton culture is now going on in the Salt River Valley and other irrigated districts of Arizona and may bring the crop within the range of the native weevils.

O. F. COOK

BUREAU OF PLANT INDUSTRY,
U. S. DEPARTMENT OF AGRICULTURE,
December 18, 1912

THE AMERICAN SOCIETY OF ZOOLOGISTS

THE Eastern and Central Branches of the American Society of Zoologists met in joint session at Western Reserve University, Cleveland, Ohio, December 30 and 31, 1912, and January 1, 1913, in conjunction with the American Association for the Advancement of Science and the American Society of Naturalists.

The following officers of the Eastern Branch were elected for the year 1913:

President—Raymond Pearl, Maine Agricultural Experiment Station, Orono, Me.

Vice-president—Alexander Petrunkevitch, Yale University, New Haven, Conn.

Secretary-treasurer—Caswell Grave, Johns Hopkins University, Baltimore, Md.

Additional Member of the Executive Committee—C. E. McClung University of Pennsylvania, Philadelphia, Pa.

These officers, in addition to R. G. Harrison (elected at the Ithaca meeting in 1910) and H. E. Jordan (elected at the Princeton meeting in 1911), will constitute the executive committee of the Eastern Branch for the ensuing year.

The present officers of the Central Branch continue until the next meeting of this branch.

The president of the society as a whole until the next joint meeting is Henry B. Ward, University of Illinois, Urbana, Ill.

The following persons were elected to membership in the American Society of Zoologists:

Eastern Branch—Ethel N. Browne, Princeton University; Esther F. Byrnes, Brooklyn High School for Girls; Wayland M. Chester; C. G. Crampton, Massachusetts Agricultural College; Edward C. Day; Alfred O. Gross, Bowdoin College; E. Newton Harvey, Princeton University; Davenport Hooker, Yale University; Otto F. Kampmeier, University of Pittsburgh; Henry Laurens, Yale University; Samuel C. Palmer; Edward E. Wildman, West Philadelphia High School.

Central Branch—Alexander MacGillivray, Cornell University; Gideon S. Dodds, University of Missouri; George A. Baitsell, Central College; W. C. Allee, University of Illinois; Aute Richards, University of Texas; Bertram G. Smith, State Normal School, Ypsilanti, Mich.; William Scott, University of Indiana; W. A. Willard, University of Nebraska; Addison Gulick, University of Missouri; Robert K. Nabours, Kansas Agricultural College; Mary T. Harmon, Kansas Agricultural College.

Elected to honorary membership, in recognition of his services to American zoology, Honorable James Bryce, British Ambassador to the United States.

Professor Nutting reported that the committee on zoological nomenclature, appointed by the Central Branch at its last meeting, had published its report in SCIENCE, December 13, 1912. The report was approved.

Professor S. A. Williston was elected a delegate at large to the Eighth International Zoological Congress at Monaco and requested to present the above report to the congress. The executive committee of the society was authorized to appoint an alternate.

The report of the treasurer of the Eastern Branch was presented as follows:

Receipts

Investments:	
From Raymond Pearl, Certificate of Stock No. 11,865 Industrial Savings and Loan Co	$150.00
Current funds:	
Received from R. Pearl	195.41
Interest on current funds	2.18
Dividend from stock	3.75
Dues from members	187.00
From treasurer Central Branch, for share of printing members' list	18.95
Total receipts in current funds	$407.29

Disbursements

Smoker, Princeton meeting	$7.00
Express on records from Orono, Me.	1.15
Postage and envelopes	15.90
Membership cards and receipt book	2.75
300 copies list of members ($45.00) with envelopes	46.35
Clerical assistance	5.98
Fees of notary and clerk of court	.77
Secretary's ticket, Hanover to Cleveland	36.10
Total disbursements	$116.00

Total receipts, as above	\$407.29
Deduct total disbursements	116.00
Balance in current funds	\$291.29

The report was approved by an auditing committee and accepted by the society.

The treasurer reported the failure of the Industrial Savings and Loan Co. in which the permanent funds of the Eastern Branch had been invested by a former secretary-treasurer. The treasurer, Professor J. H. Gerould, was appointed custodian of the claim on the fund so invested in order that legal processes incident to the change of treasurers might be avoided.[1]

Mr. Mayer offered resolutions upon the deaths of Professors T. H. Montgomery and Nettie Stevens. These were adopted by the society and the secretary instructed to publish them in SCIENCE and transmit copies to the families of the deceased members.

The society passed the following resolution by unanimous vote:

WHEREAS: It is essential to the advancement of the interests of American fisheries both at home and abroad that the commissioner of fisheries should be a man of the highest scientific attainments, as well as one of wide practical experience in the varied activities of the Bureau; therefore,

Be it Resolved, That the American Society of Zoologists, in session at Cleveland, Ohio, without expressing preference for any particular candidate, earnestly urge upon the President-elect, in the event that a change be made in the administration of the United States Bureau of Fisheries, the selection of a person for this office who is recognized as a trained zoologist, who has shown marked ability in the practical application of zoological methods and results, who is thoroughly familiar with the problems of American fisheries, and who possesses the ability so to organize and administer the affairs of the bureau as to bring the efficiency of its work to the highest development.

[1] At a meeting of the executive committee it was resolved that the funds of the society should for the present be invested only in savings banks or other institutions recognized as suitable depositories for trust funds and that the treasurers of the two branches should confer during the coming year and present recommendations for the investment of the society's funds not held for current expenses.

A committee consisting of E. G. Conklin (chairman), H. V. Wilson and A. G. Mayer was appointed to present this resolution to the President-elect.

After consideration and discussion of a motion by Professor C. C. Adams, the society voted to give the officers power to act for them in the support of both state and national legislation looking toward the protection and conservation of wild animals.

The following papers were presented at the meeting, either in full or by title:

ECOLOGY AND BEHAVIOR

A. S. PEARSE (University of Wisconsin): *The Beaches at Nahant, Mass.*

S. R. WILLIAMS (Miami University): *Notes on the Distribution of Thermobia domestica and Lepisma saccharina.*

These two *Thysanurans* are common in the house in Oxford in which I live, *Thermobia* in the attic and *Lepisma* in the cellar. The conditions of moisture and temperature are of course very different at the two levels. Daily records from July 11 to September 11, our hottest weather, gave the following results:

Cellar.—Highest record of maximum thermometer, 27° C., July 15. Lowest record of the minimum thermometer, 17° C., August 6. Average for two months, maximum, 22.7°; minimum, 19.5°.

Attic.—Highest record of maximum thermometer, 41° C., July 14. Lowest record of minimum thermometer, 11.5° C., August 4 and 5. Average for two months, maximum, 33.9°; minimum, 20.7°.

Animals of both species were kept in jars in the attic. It was found that when the temperature reached 40° C. or more, as it did July 14, 15, 24 and September 3, the *Lepisma* died, the last to succumb being young which hatched from eggs laid in the jars. To test this experimentally some *Lepisma* and *Thermobia* were heated over a water-bath in a flask with a thermometer passing through the cork. It is difficult to keep the animals from burning to death on the hot glass of the flask but an insulating material was put in the flask. All *Lepismas* died while the air-temperature of the flask was not beyond 40° to 43° C., while *Thermobia*—known in England as the "fire-brat"—died at 47° to 48°. This indicates experimentally that *Lepisma* is unable to withstand the heat of an average summer in an attic at our latitude and hence does not go there, while *Ther-*

mobia endures such heat easily. The arrangement of the scales on the two forms is likely a part of the explanation of the distribution, since they lie flatter and less loosely on *Lepisma* than they do on *Thermobia*. Further observations are being carried on with reference to the moisture relations of the two forms in these habitats.

V. E. SHELFORD (University of Chicago): *An Experimental Study of the Reactions of certain Animals to Gradients of Evaporating Power of Air.* (Lantern.)

Millipedes, ground beetles and amphibians inhabiting moist forests react negatively, usually by turning back, when they encounter air of high evaporating power. The negative reaction usually begins after several trials of the air of high evaporating power. The reactions are similar when the evaporating power is due to current and when due to dryness, but in some cases they are more pronounced when it is due to higher temperature. Comparable animals from habitats where evaporation is great do not react sharply to the gradients used with the forest animals. Sharpness of reaction is not correlated with the length of time required to kill the animals with dry air.

J. W. SCOTT (Kansas Agricultural College): *The Viability of certain Cystocerci in Pigs and in Young Dogs.*

A series of experiments was tried to determine whether hogs are injured by feeding upon rabbits that are infected with the cysticerci of *T. serrata* and *T. serialis*. When corn is scarce it is a common practise for farmers in the western part of Kansas to feed jackrabbits to their hogs instead of corn. The intermediate host of *T. serrata* is the cottontail or common wild rabbit, but this parasite is occasionally found in the jackrabbit. In the vicinity of Manhattan out of a total of sixty-one rabbits examined during the winter of 1911–12, fifty-one (nearly 84 per cent.) were infected with cysticerci of *T. serrata*. The multiple cyst of *T. serialis* is found occasionally in the cottontail but is very common in the jackrabbit. This cyst may grow as large as a goose egg, and a single jackrabbit may have as many as half a dozen or more of these so-called "waterblisters" in various stages of development. Cysticerci from both species of tapeworms were fed to pigs weighing from seventy-five to ninety pounds, care being taken to prevent injury to the cysts before they were swallowed. Though a large number of cysticerci were fed, not a single tapeworm was found when the pigs were killed ten days later. When the same kinds of cysticerci were fed to young dogs from 90 per cent. to 100 per cent. were recovered in the form of young tapeworms. These experiments indicate a very high degree of specialization of the parasite with reference to its optimum environment.

A full account of these experiments, together with the time required for transformation, rate of development and effect upon the definitive host, will be published later.

C. C. ADAMS (University of Illinois): *Ecological Surveys.*

R. H. WOLCOTT (University of Nebraska): (1) *Some Aspects of Faunal Conditions in Western Nebraska.* (Lantern.) (2) *Biological Work in the Alkali Lakes of Cherry County, Neb.*

F. B. ISELY (Central College) (introduced by W. C. CURTIS): *Experimental Study of the Growth and Migration of Fresh-water Mussels.*

About 900 specimens, representing eleven species, of fresh-water mussels were tagged, weighed, measured, initial records taken and planted (returned to the stream or pond) by the writer in June, 1910. Many of these specimens were reclaimed, a number of times, and further records taken in 1910, 1911, 1912. Tabular results concerning the growth and migration of 122 of the specimens under observation are given.

A few points from the summary may be stated as follows:

1. Rate of growth is exceedingly variable.
2. The summer months are the growth months.
3. Lines of arrested growth may be called *rest rings*, the conspicuous ones being usually winter rest rings; occasionally, the rest rings may be two or more years apart, more often, however, several equally prominent rings may be formed in one year. Prominent rest rings are generally due to double prismatic and epidermal layers.
4. Under favorable environmental conditions there is little migration, especially among the Quadrulæ.

J. E. WODSEDALEK (introduced by A. S. PEARSE): *Some Results of Studies on Behavior and Starvation of Dermestidæ.*

NATHAN FASTEN and GEORGE WAGNER (University of Wisconsin): *The Behavior of a Parasitic Copepod, Lernæopoda edwardsii.*

This copepod is exclusively parasitic on the brook trout (*Salvelinus fontinalis*). During its free-swimming existence, not more than two days

at the most, it is strongly positive to intense illumination, whereas in light of low intensity it remains indifferent. On that account the copepod swims about close to the surface of the water throughout most of the day, with a spiral, dart-like motion, which in many respects is similar to the locomotion of the hunter ciliates. At night it sinks to deeper regions, due to its high specific gravity. These migrations are parallel with those of the brook trout and are, therefore, of great advantage to the life of the parasite. Increasing the temperature of the water, even to a degree that proves fatal, does not alter the reaction of the copepod to light. Chemicals also, such as sodium chloride, potassium chlorate, copper sulphate, calcium chloride, hydrochloric, sulphuric, tartaric and oxalic acids cause no reversal in the behavior of the copepod to light. In hydrogen-peroxide, magnesium sulphate, nitric and acetic acids indications of reversal were noticeable. The copepod reacts quickly to pieces of gill of the brook trout, but not at all to those of rainbow trout.

COMPARATIVE ANATOMY

ALEXANDER PETRUNKEVITCH (Yale University): *The Origin of Arachnida in the Light of Paleontological Evidence.*

EDWIN LINTON (Washington and Jefferson College): *Note on a Viviparous Distome.*

A distome (species not yet determined) found in the cloaca of a herring gull at Woods Hole, Mass., July 22, 1912, is unique in that the folds of the uterus contain ova in which active, ciliated larvæ (miracidia) have developed. The larvæ are conspicuous on account of the black pigment eye-spots. When the larvæ are set free from the parent worm each is seen to contain a single well-developed redia.

So far as the early stages of distomes have been observed in the marine invertebrates of the Woods Hole region they show a much less complicated life-history than that of the liver fluke. Sporocysts have been found (in certain mollusks and one annelid) some containing tailed, others tailless cercariæ. None were seen with rediæ. In those cases the redia stage is missing. In this distome from the herring gull the sporocyst stage is evidently omitted.

J. F. ABBOTT (Washington University): *Adaptations for Air-breathing in the Ocypod Crabs.*

F. D. BARKER (University of Nebraska): *A Contribution to the Parasitic Turbellaria.* (Lantern slides and demonstrations.)

While working on the parasites of the fishes at the Bermuda Biological Station last summer two new species of parasitic turbellaria were found in the posterior sacculated portion of the intestine of the Bermudian holothurian *Stichopus*, both the black and the spotted varieties harboring the parasites.

In Bronn's "Klassen und Ordnungen des Thier-Reichs," 1908: 2574, forty-seven parasitic turbellaria are enumerated. These are classed as ecto- and ento-"Raumparasiten" and ecto- and ento-parasites; the latter are further divided into cœlomic, liver, kidney and intestinal parasites.

Parasitic turbellaria have been found in the following hosts: annelids, gephyreans, crustaceans, echinoids, holothurians, lamellibranchs and gastropods. Six species representing two genera have been reported for holothurians in general and one species, *Anoplodium schneideri*, has been described by Semper as occurring in the intestine of the holothurian *Stichopus variegatus*. With the exception of two species, the parasitic turbellaria of the holothurians occur in the body cavity. Not all of the holothurians examined were infected and in no case was the infection severe, twelve parasites being the largest number found in any one host. Both species of turbellaria were found in only one third of the animals examined, the larger elongated parasite being the more abundant.

The preliminary study of these turbellaria and a comparison with the known parasitic turbellaria shows them to be new and undescribed species and thus adds two more parasitic turbellaria to the list.

The detailed description of these forms will be published soon and will be followed by a further study of the histology and life history of these turbellaria with the hope of settling or giving new light and additional knowledge on a number of points concerning trematode and turbellarian morphology and histology which are now in dispute.

H. S. PRATT (Haverford College): *The Trematode Parasites of the Loggerhead Turtle.*

The parasites of the loggerhead turtle (*Caretta caretta*) have been studied from the Mediterranean Sea and the Gulf of Mexico. The two principal localities in the Mediterranean region where they have been collected are Trieste and Alexandria, where a large number of the turtles have been investigated for parasites by well-known zoologists from the time of Rudolphi to the present. In the most recent times Braun and

Looss have been the most active in this field. In the Gulf of Mexico three turtles have been investigated by Professor E. Linton and two by myself at the laboratory of the Carnegie Institution of Washington situated on Dry Tortugas. In all, nineteen species of trematodes have been found. Of these, nine species occurred in the turtles of the Gulf of Mexico, of which eight species live also in those of the Mediterranean Sea, only one species being peculiar to the former locality. Ten species which occur in the Mediterranean have not yet been obtained in the Gulf of Mexico, although the probability that some of them at least will be discovered there when a larger number of loggerheads are investigated is a strong one.

The most numerous trematode occurring in the Gulf of Mexico loggerheads is *Cymatocarpus undulatus*, several thousands of this species having been found in the duodenum of each of the five turtles investigated. This worm is apparently not common in the Mediterranean, not having been found at all off the Italian coast, although it has been taken a number of times at Alexandria. Among the individuals of this species in the duodenum of two of the turtles were many specimens of *Rhytidodes gelatinosus*, and in the intestine of two turtles was *Pachypsolus ovalis* many worms being present in one case and but two in the other. This last-named worm is the only species which is peculiar to the Gulf of Mexico, but its similarity to *P. irroratus* of the Mediterranean is so great that it is a question if it is not identical with it. The urinary bladder and rectum of two turtles contained many specimens of *Plesiochorus cymbiformis* and in the intestine of one turtle were two specimens of *Monostomum pandum*, while in another was found a single *Cricocephalus delitescens*. *Orchidasmus amphiorchis*, which is a very common worm in the Mediterranean, was found in only one turtle, and then in small numbers.

Further discussions of these trematodes with descriptions of those which are as yet insufficiently known will be published in the *Archives de Parasitologie*.

J. W. SCOTT (Kansas Agricultural College): *Note Concerning the Origin of the Introvert in Cirratulus.*

R. M. STRONG (University of Chicago): *Further Observations on the Olfactory Organs of Birds.*

In a study of the olfactory organs of birds, I found that the fulmar has very large olfactory lobes which are in immediate contact at their anterior ends with the posterior ends of the nasal chambers. There are no so-called olfactory nerves.[3] Since the paper which described that condition was published I have studied the olfactory organs of a number of species of the order to which the fulmar belongs, *i. e.*, the Tubinares. In all of these species similar conditions prevail, though the relative size and form of the olfactory lobes varies. The anterior turbinal is small in the Tubinares, but the other two turbinals are well developed. The posterior turbinal, to which most of the olfactory epithelium is apparently confined, is relatively large, especially in the storm petrels. The results of this work will be published later in connection with a study of the anatomy of the Tubinares.

A. W. MEYER (Stanford University): *Degenerative and Obliterative Changes in the Fetal Vessels and Ligaments.*

The observations which I desire to report were made quite incidentally in connection with other investigations. Hence in spite of the fact that a rather large series of animals were examined, they should not be considered as being exhaustive. The first matter of some interest in connection with these fetal structures is the entire absence of a ligamentum teretis hepatis and a ligamentum suspensorium hepatis in *Canis familiaris* and *Ovis aries* and probably also in bovines. In view of current descriptions and conceptions this seemed a rather surprising fact and I was further surprised that the statement also holds for old specimens of *Felis domestica* and *Cavia cabaya*, although in them the complete disappearance of these structures is comparatively slower. In *Canis familiaris* and *Ovis aries* both the vena umbilicalis and the ligamentum suspensorium hepatis disappear by the end of the second or third month of fetal life, as a rule, but they persist much longer in the other animals mentioned.

Since the umbilical vein disappears so early in both the dog and sheep it would of course be incorrect to say that a ligamentum teres was ever formed or existed in them. On the other hand, in cats, rabbits, guinea pigs, rats, etc., in which the degeneration is much slower and where it may be partial, a more or less temporary round hepatic ligament may hence be formed.

In the dog and the sheep the degeneration and regression of the umbilical vein and suspensory ligament of the liver take place *pari passu* as a rule, and they may even be somewhat interdependent or at least inter-related processes.

[3] See Strong, 1911, *Jr. Morph.*, Vol. 22, No. 3, pp. 619–660.

Moreover, the distal extremity of the degenerating umbilical vein after being freed from the abdominal wall may obtain a secondary attachment as a result of the formation of adhesions, to the parietal peritoneum usually somewhat more cranial to the umbilicus; to the liver or gall bladder; or most commonly to the extensive fold of extraperitoneal fat lying ventrally in the median line between the processus xiphoideus and the umbilicus. Besides, such secondary attachments—which are, of course, purely temporary—may nevertheless retard the progress of the degenerative changes in the umbilical and omphalo mesenteric veins considerably. This is especially well illustrated in case of the omphalo mesenteric veins of the cat which are not rarely present still in cats one to two years old because they have come into more or less permanent relations to, and function as part of the systemic venous system. This rather surprising fact was especially well illustrated in two cats in which one of the omphalo mesenteric veins had obtained a secondary attachment to the apex of the bladder and arose in several vesicle veins. In these cases the omphalo mesenteric vein was patent throughout, filled with blood which could be forced into the superior mesenteric vein very easily by pressure and which was later expelled spontaneously by contraction in response to cooling of the vessels after death. A similar phenomenon was noticed in case of the umbilical vein of the cat, the distal degenerated and retracted extremity of which obtained a similar connection with the extra-peritoneal veins of the ventral body wall. It is evident, of course, that the establishment of such secondary vascular connections on part of the umbilical vein might and does materially affect the rate of regression, not only of the vein itself, but of the suspensory ligament as well. This is particularly true if, as is not infrequently the case in cats, a very large lymphatic vessel lying between the layers of the suspensory ligament extends parallel to its concave and free caudal border.

The extremely late disappearance of the omphalo mesenteric vessels in the cat not uncommonly observed is as remarkable as the early disappearance of the umbilical vein in the dog and sheep. Indeed it is not rare to find the omphalo mesenteric vessels persisting as fine fibrous strands which may contain no remnant of the lumen and which have obtained a secondary attachment elsewhere, in cats half a year to a year old.

The umbilical arteries which retract intra-abdominally instantaneously at the time of rupture of the cord in *Bos taurus* and *Ovis aries* were never found to have secured such a secondary attachment, but in *Canis familiaris, Felis domestica, Lepus cuniculus, Mus rattus* and *Cavia cobaya,* in which they remain attached to the abdominal wall at the umbilicus and become detached only one to two weeks *post natum,* their free ends obtain a firm secondary attachment to the apex of the bladder in the majority of cases. Yet they were never observed to come into relation to the systemic arterial system with their free ends or their degenerating trunks.

The early complete disappearance of the umbilical vein of the dog and sheep was due to a degeneration of its musculature and consequent absorption. These degenerative processes which in these animals were sometimes accompanied by a certain amount of connective tissue invasion never ended in the formation of a truly ligamentous structure, however. In the cat, rabbit and guinea-pig, on the contrary, such a transformation into connective tissue of at least the distal portion of the umbilical vein was not uncommon.

In case of the umbilical arteries in any of these animals two methods of transformation were observed. The connective tissue which displaced the musculature arose either of subintimal or adventitial origin. In the first case it formed between the intima and the elastica interna when present, which was usually the case, while in the second case it displaced and invaded the media from without. However, since there is a great deal of connective tissue between the fasciculi and concentric layers of muscle fibers of fœtal vessels, both these processes may also be accompanied by proliferation of the inter-fascicular, intra-medial connective tissue. Moreover, it is evident that these processes may all be combined. Nevertheless, this was usually not the case and instances were observed in which the musculature was plainly degenerating and being displaced only from within, for the outer layers were well preserved, while in other cases exactly the opposite conditions were present.

No evidence whatever for the origin of connective tissue from endothelium was obtained and the initiation of degeneration and transformation were apparently independent of thrombus formation, but apparently not of the presence of non-coagulated blood in the lumen of the vessel.

L. B. Walton (Kenyon College): *The Anatomy of the North American Land Planarians.*

A. M. REESE (West Virginia University): *The Histology of the Enteron of the Alligator while Hibernating and while Feeding.*

The chief object of this investigation was to determine the effect of hibernation upon the digestive tract of the alligator, and incidentally to study the histology of these structures, which has not, so far as the author is aware, been done before in any detail.

The material used was taken from young animals at the end of a feeding period of about five months, and towards the end of the hibernating period after fasting for four or five months.

The regions of the enteron that were studied were as follows: the tip and base of the tongue; the anterior and posterior regions of the roof of the mouth; the anterior and posterior regions of the esophagus; the cardiac, fundic and pyloric regions of the stomach; the anterior, middle and posterior regions of the small intestine; the anterior and posterior regions of the rectum.

Since the work was started at the end of the hibernating period the tissues of that period were studied and drawn first.

The only difference between the structure of the tip of the tongue during hibernation and during the feeding season is that the scaly epithelium with which it is covered is somewhat thicker and more compact in the former than in the latter condition, though even this difference may have been due to differences in the ages of the animals used. The base of the tongue differs from the tip in having a thicker epithelium and in having compound, tubulo-alveolar glands. These glands in the hibernating animal have many more alveoli than in the feeding animal, though this, again, may have been due to the difference in age.

The lining of the roof of the mouth is essentially the same as that of the tongue. The glands are found only in the posterior region. The slight differences in the papillæ here found may easily be due to the difference in age.

The esophagus shows the usual layers for that region. Its epithelium is partly ciliated in the anterior part. The muscularis mucosa is very scant in the anterior region. The only difference between the two stages is that in the feeding the muscularis mucosa in the anterior region is much more strongly developed than in the hibernating stage; and in the former the nuclei are not arranged in two zones as in the latter.

The stomach has the usual layers, and has essentially the same structure in the three regions studied, except that the wall in the fundic region is much the thickest, due mainly to the great thickness of the middle muscular layer. Only one kind of cell is found in the gastric glands. No difference is to be noted between the hibernating and the feeding conditions.

The chief peculiarity of the small intestine is the apparent entire absence of the submucosa. Goblet cells are also wanting. The greater diameter of the anterior region is due both to the greater diameter of the lumen and to the greater thickness of the walls. The middle and posterior regions have about the same diameter, though the mucosa becomes thinner and less complicated caudad. There is practically no difference between the hibernating and feeding stages.

The anterior and posterior regions of the rectum have essentially the same structure. No difference can be seen between the hibernating and feeding conditions.

The differences, then, between the digestive tracts of the hibernating and feeding animals are so slight that it may be said that hibernation has practically no effect upon the enteron of the alligator, at least in captivity.

F. W. CARPENTER (University of Illinois): *Methylene Blue Preparations of Nerve Endings in Cranial Autonomic Ganglia.* (Demonstration.)

H. L. BRUNER (Butler College): *Jacobson's Organ and the Respiratory Mechanism of the Urodeles.*

In the amphibians the relation between respiration and smell is complicated by the peculiar nature of the respiratory mechanism, which includes an apparatus for closing the nasal passage. In this group Jacobson's organ, when present, is a blind sack or groove opening into the general olfactory cavity. According to the theory of Seydel (1895) it is stimulated by odorous material which passes through the choana from the mouth. The organ in question has been recognized in the *Anura* and *Salamandrida* and among the lower urodeles, in *Cryptobranchus* and *Amphiuma*. It is wanting in *Proteus* and *Necturus*.

Among the amphibians studied, the organ of Jacobson is present in all forms in which the expiratory media pass through the nose in adult life. In *Necturus* and *Proteus* access to the nasal cavity from the mouth is prevented by a mechanical breathing valve at the choana and the organ

of Jacobson is wanting. Seydel assumed that this simple condition of the olfactory organ of *Necturus* is a primitive one, but it seems more probable that the organ has degenerated on account of the presence of the choanal valve.

J. F. DANIEL (University of California): *The Endoskeleton of Heterodontus francisci.*

F. D. BARKER (University of Nebraska): *The Parasites of the Muskrat.* (Lantern slides and demonstration.)

With the exception of a brief note by Leidy, 1888: 126, there is no reference to or description of the parasites of our common muskrat.

A recent examination of 27 muskrats trapped along the Loup River in Nebraska revealed a heavy parasitic infection. Over 600 worms were found, including trematodes, cestodes and nematodes. Seven species of trematodes, one species of cestode and two species of nematodes were represented.

The work on the trematodes which is now completed shows all seven species to be new and heretofore undescribed with one possible exception, and in that case there is only the meager description of Leidy referred to above.

The large number of different and new species of parasites which occur in the muskrat but emphasizes the virgin and fertile nature of the field of parasitology for the investigator and also emphasizes the need and the value of a thorough survey of the parasitic fauna of our common animals by states, or better, by smaller units of area.

The description of one of the trematode parasites of the muskrat has been published and the descriptions of the other six species will appear soon.

R. J. GILMORE (introduced by F. C. WAITE): *Variations in the Pelvic Girdle of Diemyctylus viridescens.*

W. E. SULLIVAN (introduced by F. C. WAITE): *Zones of Growth in the Skeletal Structures of Pseudopleuronectes americanus* (*Walb*).

W. A. WILLARD (University of Nebraska): (1) *The Epidermal Sense Organs of Anolis carolinensis.* (2) *A Case of Complete Twin Formation in Squalus acanthias.*

COMPARATIVE PHYSIOLOGY

MAX MORSE (Trinity College): *The Rôle of Phagocytosis in the Process of Involution.*

Involuting organs, such as the tail of the anouridan larva, their gills, etc., have been described by Metchnikoff and others as atrophying through phagocytosis. Metchnikoff believed that the phagocytes arose from the muscle cells themselves, but sections through organs at the time of degeneration show no mitoses in the muscle cells. Others, such as Mercier, believe that the leucocytes act as phagocytes and cause the breaking down of the organs, but differential counts of blood from young larvæ, those during metamorphosis and from adults show no correlations which would indicate that polynuclear leucocytes, basophiles, eosinophiles, large or small mononuclear leucocytes play any rôle in the process. The process of atrophy here is similar in essential respects to the involution of the uterus in mammals, to the degeneration of the individuals of the bryozoan colony, etc., where the process is doubtless autolysis and experiments are in progress, which seem to show that this is the case in the metamorphosing amphibian larva.

A. G. MAYER (Carnegie Institution): *Some Effects of Ions upon the Movements of Marine Animals.*

J. F. ABBOTT (Washington University): *Reactions of Fiddler Crabs to Salt Solutions.*

H. M. MACCURDY (Alma College): *Some Effects of Sunlight on the Starfish Asterias forbesii.*

S. O. MAST (Johns Hopkins University): *The Reactions of Spondylomorum to Light, with Special Reference to the Question of Changes in the Sense of Reactions.*

H. W. RAND (Harvard University): *Reactions of the Tentacles of Sagartia luciæ to Tactile Stimulation.*

The reactions of tentacles of *Sagartia luciæ* to tactile stimulation vary from a minimum reaction consisting of a slight longitudinal contraction in a narrow zone at the level of the point stimulated, to a maximum contraction of the entire tentacle. Occasionally the response extends to neighboring tentacles or even involves the entire animal. In a certain animal at a certain time the degree of the response varies with the intensity of the stimulus. But in the same animal at different times, or in different animals at the same time and under similar conditions of experimentation, the reactions show great variation.

Two distinctly opposed physiological conditions were noted. In the one condition (designated as positive) the distinctive feature of the reaction is a bending of the tentacle at the point stimulated and toward the stimulated side. In this condition

the responses are, in general, like those involved in taking food. The distinctive feature of the second condition (negative) is a bending of the tentacle at the point stimulated but away from the stimulated side. The positive and negative conditions are not necessarily correlated with hunger and satiety, nor with the state of the medium in which the animal lives, nor with fatigue. While external conditions remain as nearly as possible constant, the animal may abruptly change back and forth from one condition to another. The reactions, therefore, while influenced by external conditions, depend essentially upon an internal physiological complex.

A. J. GOLDFARB (College of City of New York): *On the Effects of Changes in Density of Sea Water upon Growth and Regeneration.*

G. H. PARKER and E. M. STABLER (Harvard University): *Taste, Smell and Allied Senses.*

The statement that the stimulus for smell is material in the form of gas and for taste is material in solution is partially incorrect, for both sense organs are normally stimulated by solutions. It has been recently shown that fishes respond to their food by smell and taste much as air-breathing vertebrates do. What seems to be the chief difference between smell and taste is that the olfactory organs are stimulated by very dilute solutions, the organs of taste only by much stronger ones. To get some quantitative statement of this difference, the strength of the stimulating solution producing the minimum stimulus was determined for a substance that had both smell and taste. The substance tested was ethyl alcohol. In preliminary tests the following results were obtained. The weakest dilution that would stimulate the mucous surfaces of the mouth was a 15 mol. solution (aqueous). The weakest dilution that called forth the sweet taste when applied to the tongue was a 2 mol. solution (aqueous). The weakest dilution that could be smelled was 1/200,000 mol. (in air). Thus the olfactory apparatus responds to a dilution about 400,000 times greater than that for taste.

G. G. SCOTT (College of City of New York): *The Effect of Fresh Water upon Fundulus heteroclitus.*

It is now well established that *Fundulus heteroclitus* is found in both sea water and fresh water. The fact that few survive rapid transference from salt to fresh water while greater numbers survive gradual transference shows that we are here concerned with another application of DuBois Reymond's law of stimulation. Out of a lot of ten *F. heteroclitus* transferred from salt to fresh water, the present author kept one fish alive in fresh water for sixty days. When the caudal fin is removed at the time the fishes are transferred from salt to fresh water regeneration of new caudal fin tissue takes place, although in a month's time the amount is not as great as in sea water. Of greater interest from the point of view of the mechanism of adaptation are the results of experiments in which individual records were kept of changes in weight made at a number of intervals after immersion of *Fundulus* in fresh water. In some cases all members of a lot of fishes died soon after transfer. In each case a rapid increase in weight was noted. In other cases certain individuals gain weight rapidly and die. Other individuals of the lot after an initial gain in weight follow this with slight gains and losses—the net results in these survivors being a weight less than normal at the end of the experiment. The experiment apparently illustrates the power of *Fundulus heteroclitus* to change the organization of the limiting membranes and other structures of the body to the end that the fish becomes adapted to fresh water, a medium of very low osmotic pressure as compared with sea water.

MAX MORSE (Trinity College): *Factors Involved in the Metamorphosis of Amphibia.*

A. G. MAYER (Carnegie Institution): *The Vital Limits of Reef Corals in Respect to Temperature.*

S. O. MAST (Johns Hopkins University): *Thirteen Hundred Generations in Didinium without Conjugation.*

A. J. GOLDFARB (College of City of New York): *On a New Method of Grafting Embryos in Large Numbers.*

EMBRYOLOGY AND DEVELOPMENT, CYTOLOGY

ALBERT KUNTZ (University of Iowa): *The Histogenesis of the Cranial Sympathetic Ganglion in the Pig.*

H. L. CLARK (Harvard University): *Ontogenetic and Localized Stages in Ophiurans.*

C. M. CHILD (University of Chicago): *Senescence and Rejuvenescence in Planaria velata.*

B. M. ALLEN (University of Wisconsin): *Some Methods of Embryological Technique.* (Accompanied by a demonstration.)

CHARLES ZELENY (University of Illinois): *Experiments on the Control of Asymmetry in Young Serpulids.*

Caswell Grave (Johns Hopkins University): *The Egg of Ophiura, its Yolk Content and Course of Development.*

G. T. Hargitt (Northwestern University): *The Oogenesis of Campanularian Hydroids.*

The egg cells of *Campanularia flexuosa* arise from the basal half of an ordinary epithelial cell of the entoderm, the distal half remaining an epithelial cell; or else they arise by the transformation of an entire entoderm cell in the pedicel of the gonophore. In either case the cell so produced is transformed directly into an egg cell without any divisions occurring. Since the entodermal epithelial cells from which the egg cells arise are not different from the neighboring cells which retain their epithelial function, and since the distal half of a divided cell remains in position lining the cœlenteric cavity and retains its function (the proximal half forming an egg cell), there is clearly no continuity of the germ-plasm, the egg arising from a so-called somatic cell.

Coincident with the marked and rapid growth of the egg the nucleolus (which is partly chromatin) breaks up into many fragments of various sizes and shapes, and becomes highly vacuolated. At the same time there appear small granules in the cytoplasm against the membrane of the germinal vesicle, and also similar small granules are present inside the membrane; these are found to be nucleolar fragments, some of which are chromatic in character. In addition to these indications of the escape of chromatin from the germinal vesicle there are currents in the cytoplasm extending away from the nucleus, as shown by the arrangements of the cytoplasmic granules. These currents cease when the nucleolus has entirely disappeared from the nucleus through fragmentation and dissolution, and this period is also the end of the growth period of the egg. The nucleolar material which has left the nucleus goes to form the yolk spherules of the egg.

During the growth of the egg the nuclear reticulum has remained unchanged by the modifications and transformations of the nucleolar substance which has been dissolved and cast into the cytoplasm. When the nucleolus is practically all gone and the growth of the egg has ceased the chromatin of the reticulum produces the chromosomes of the polar spindle, which are ten in number. In spite of the extensive chromatin emission, coming from the dissolving nucleolus, the chromatin remaining in the nuclear reticulum is still more than is necessary for the formation of the chromosomes, and the greater part of it escapes into the cytoplasm in the form of granules when the germinal vesicle breaks. That which is not thus scattered forms the chromosomes.

To account for the large amount of chromatin which escapes from the nucleus there must be a formation of chromatin within the nucleus during the growth period of the egg, and the nucleolus is conceived to be the place where the chromatin is produced and transformed for the different functions it has to perform. In this origin of new chromatin, and in the extreme dissipation of chromatin during and after growth, it is believed that we have strong evidence against the continuity of chromatic material, and hence of the chromosomes. The chromatin is a metabolic product changing and transforming as all other constituents of the living cell.

J. F. Abbott (Washington University): *The Blood Cells and their Respiratory Pigment in Thallasema.*

H. E. Jordan (University of Virginia): *A Comparative Study of Mammalian Spermatogenesis with Special Reference to the Heterochromosomes.*

Among the forms examined, including mongoose, cat, squirrel, pig, rabbit, white mouse, sheep, horse, mule, bull and dog, heterochromosomes are lacking in the male germ-cells of the first five, and present in the remainder. The available evidence favors more the interpretation in terms of a bipartite or compound X-element than of an associated X and Y group (idiochromosomes).

In view of the fact that heterochromosomes have recently been reported in man and rat (Guyer), armadillo (Neuman and Patterson), guinea-pig (Stevens) and opossum and bat (Jordan), the evidence indicating similar elements in the above enumerated group of six common mammals would seem to warrant the conclusion that sex-chromosomes are very generally present in mammals. Universality of presence seems vitiated for the present by the fact that in another group of five mammals such elements seem unquestionably lacking. It might be assumed that such elements are actually present in the male germ-cells, but so small or labile as to elude detection by present methods, or not presenting the usual morphology of heterochromosomes during the prophase stages. The unmistakable presence, however, of a "split-accessory" in the female germ-cells (primary oocyte) of the cat, as recorded by Winiwarter and Sainmont, and the absence of

any X-element in the male, suggests very forcibly that sex-chromosomes are present in all mammals, generally in the male, exceptionally in the female. The same end would be attained, that of numerical sex-equality, whether present in the one or the other sex. If this hypothesis can be further sustained, it would seem cogently to reinforce the evidence for an essential sex-determining function of heterochromosomes. Interpreted in terms of Mendelian heredity-formulæ, in those mammals in which an X-element is present in the male, the female sex is homozygous, the male heterozygous. The facts would seem to fit the hypothesis that the accessory chromosome acts as a deterrent to the development of maleness; or more accurately, and in keeping with a quantitative interpretation of sex in the last analysis, the accessory with its egg-homologue (two X-elements) inhibits male sex development; the single egg-homologue in males being insufficient to counteract the male tendency, thus giving origin to male individuals.

The complete paper will appear in a Carnegie Institution publication.

A. W. MEYER (Stanford University): *Observations on Giant Cells in Hemal Nodes and Accessory Spleens.*

M. F. GUYER (University of Wisconsin): *Remarks on the "X" Element in Fowls.* (Demonstration.)

A reexamination of old material and a further study of new material from the Langshan cock abundantly confirms the original finding of an accessory chromosome which passes undivided to one pole of the spindle in the division of the primary spermatocyte. The element in question was demonstrated through the microscope to members of the society.

T. S. PAINTER (introduced by A. PETRUNKEVITCH): *Spermatogenesis in Spiders.*

A cytological difference has been found in the spermatogenesis of the dimorphic males of the jumping spider, *Mævia vittata.* The "gray variety" contains two supernumerary chromosomes which do not divide in the last spermatogonial division. During the first maturation division these bodies show a definite association for the accessory chromosome and pass with the latter to one pole of the cell at this time. For this reason these supernumeraries have been called "ctetosomes" (implying, are the property of, are associated with, some other body). During the second maturation division the accessory chromosome divides, but this could not be certainly determined for the "ctetosomes." As a result of the unequal spermatogonial division the sperm are of three types: (1) sperm which bear the accessory chromosome and "ctetosomes"; (2) sperm which bear the accessory chromosome only; (3) sperm which bear neither of these elements.

The "tufted variety" of male lacks the "ctetosomes" although a supernumerary chromosome may be present. This body shows no relation for the accessory chromosome and seems to follow no definite law of distribution. Hence it was called a "planosome" (indicating that it wandered through the cell mitoses).

"Planosomes" have been found in many families of spiders. Most abundant in *Amaurobius sylvestris*, which may carry as many as seven "planosomes" and three "ctetosomes."

The females of *Mævia vittata* carry two doses of the accessory element.

G. L. KITE (introduced by OSCAR RIDDLE): *Studies on the Physical Properties of the Structural Components of Protoplasm.*

MARY T. HARMON (introduced by J. W. SCOTT): *The Character of Cell Division in the Sex Cells of Tænia teniæformis.*

GENETICS

H. H. NEWMAN (University of Chicago): *Five Generations of Congenital Night-blindness in an American Family.*

During the past two years the writer, in colaboration with Miss E. L. Brown, a former student of his and a member of the affected family, has obtained data concerning 76 individuals belonging to a family connection showing a peculiar type of hereditary night-blindness. The family originated in North Carolina, but now resides in Texas. The defect is present through life and is usually, though not always, associated with myopia and strabismus. This complex of optic affections is inherited from affected men through unaffected daughters to some of the grandsons, and in no other way. Thus, as in the case of color-blindness, the character, gains expression only in alternate generations. The mechanism underlying this mode of inheritance is probably closely allied to that described by E. B. Wilson as underlying the inheritance of white eyes in *Drosophila.*[3] According to this scheme the factor for night-blindness is contained in the X chromosome, which Guyer has described for man. Frequently associated with night-blindness, but neither sex-limited nor

[3] See *Journ. Morph.*, Vol. 22, No. 1, p. 96.

linked with the night-blind complex is a fairly common optic disease known as pterygium. The factor for this defect is evidently not carried by the X chromosome.

F. E. LUTZ (American Museum of Natural History): *The Offspring of Certain Wing-mutants X Normal Drosophila and Sexual Dimorphism.*

H. S. JENNINGS (Johns Hopkins University): *Biparental Inheritance and the Question of Sexuality, in Paramœcium.*

A. M. BANTA (Station for Experimental Evolution): *Selection within Pure Lines in Daphnia.*

Conceiving that the modification of a physiological character by selection within a pure line may perhaps be more readily brought about than the molding of a structural or morphological change, if either is to be accomplished, selection within pure lines in *Daphnia* was attempted on the basis of a purely physiological character. The character chosen was the reaction time of the young daphnids under precise conditions to a definite intensity of light.

Selections were begun in 13 lines after they had been reared under laboratory conditions as pure lines, reproducing parthenogenetically, for from six to eight generations. The selections have continued through from 19 to 25 generations in the various lines with a + strain, a strain selected for greater reactiveness to light, and a — strain, selected in the reverse direction, in each pure line. Comparing corresponding + and — strains by broods there is considerable variation in the mean reaction time, the + strain sometimes having the lower reaction time, *i. e.*, being presumably the more reactive to light, and sometimes, *though less often*, the — strain having the lower reaction time. The general trend of the results is better shown by throwing the data into larger groups. Comparing all the + strains with all the — strains by two-month periods for the whole time during which the selection has continued it has been found that during two (the first and the third) of these five two-month periods the + strains had a higher general average reaction time by an average of 12 seconds. During the other three periods (second, fourth and fifth) the — strains had a higher reaction time by an average of 43 seconds. The general average reaction time of all the individuals of all the + strains for the entire period after selection began (944 individuals) has been 386 seconds and the corresponding average for the — strains involving 1,013 individuals has been 410 seconds, 29 seconds or 8 per cent. more than for the + strains. Compared with the + strain the average reaction time has been significantly larger (*i. e.*, 2½ or more times the probable error) in the — strain in five of the lines. In another of the lines, however, an almost equally large difference in the reverse direction occurred.

RAYMOND PEARL and H. M. PARSHLEY (Maine Agricultural Experiment Station): *The Experimental Modification of the Sex-ratio in Cattle.*

A. F. SHULL (University of Michigan): *The Life-cycle and Sex in Thysanoptera.*

OSCAR RIDDLE (Carnegie Institution): *Chemical and Energy Differences between the Male- and Female-producing Ova of Pigeons.*

L. J. COLE and F. J. KELLEY (University of Wisconsin): *The Inheritance of Certain Color-patterns in Pigeons.*

H. H. NEWMAN (University of Chicago): *On the Unique Mode of Inheritance in the Nine Banded Armadillo.*

The study of 140 female armadillos and their offspring has shown that minute personal peculiarities, such as double, half and split scutes, double and fused bands, are strongly inherited though interchangeable in their inheritance. All of the 63 mothers that show any of these peculiarities have one or more affected offspring. About half of the unaffected mothers have affected offspring, due evidently to affected fathers, since the characters are in no way sex-limited. These characters appear sometimes unilaterally, sometimes bilaterally in the mothers. When unilateral in the mother it may reappear bilaterally in some of the offspring and unilaterally in others; or it may appear in some and be entirely wanting in others of the same set of quadruplets. When the character appears unilaterally in several of the offspring it is usually distributed so as to produce mirrored image effects between pairs or between the individuals of a pair. The characters appear to have been distributed among the four fœtuses by means of a series of dichotomies of some inheritance factor, which can be best conceived of as having a material and highly localized existence—in short as a Weismannian determiner. The facts may, however, be interpreted equally well, and perhaps more acceptably, by taking into account that the cells of all the fœtuses are heterozygotic in origin and that the appearance of an inherited character or its failure to appear may be due to varying degrees of success in the struggle for

supremacy between maternal and paternal inheritance forces.

OSCAR RIDDLE (Carnegie Institution): *Different Degrees of the Sex Character Indicated by the Sex Behavior of Some Female Pigeon Hybrids.*

L. J. COLE (University of Wisconsin): *Two Yellow Mutants of the Common Meadow-vole.*

H. D. GOODALE (introduced by A. M. BANTA): *Additional Cases of Ovariotomy in Fowls and Ducks.*

The development of male characters in three female birds following the removal of the ovary has been previously reported. It is the purpose of this note to present, very briefly indeed, additional data obtained from experiments made the past season on birds ranging from five to twenty weeks of age at the time of the removal of the ovary.

Ducks.—Fifteen females were operated on, not including a few that died as the result of the operation. In three of these cases, owing to hemorrhage, it was impossible to remove all the ovary. These three birds did not assume any male characters. In the twelve remaining cases, the birds all began to develop the male plumage, but after a short time three individuals reverted to their original type. The cause of this reversion became apparent, when, on examination, it was found that the ovaries had partially regenerated. The remaining nine individuals have continued to acquire the male's plumage, that is, as the female feathers drop out they are replaced by feathers like those of the corresponding male. In five of these last cases it has been ascertained by a second operation that the ovary was completely removed. Although in several of these cases, the transformed females are, externally at least, almost perfect replicas of the corresponding male; nevertheless, the voice remains that of the female even in those cases where the adult voice was acquired several weeks after the operation.

Fowls.—Operations were performed on 18 birds. Four disappeared, four are still too young to show male characters and in three cases only part of the ovary was removed. These last did not assume any male characters. In all the remaining cases but one the male habit is developing in its entirety, viz., plumage, spurs, comb and wattles. The one exception noted that reverted to the female type after a time was due, as examination showed, to the regeneration of the ovary.

Summing up all these cases in both kinds of birds, there is a total of 24 individuals which, at the time of writing, have assumed male characters following ovariotomy.

JOHN DETLEFSEN (introduced by J. H. GEROULD): *Genetic Studies on a Cavia Species Cross.*

O. L. JONES (introduced by L. J. COLE): *Some Results of a Study of Pigmentation in Pigeons.*

MISCELLANEOUS TITLES

JACOB REIGHARD (University of Michigan): (1) *On the Breeding Behavior of the Log Perch (Percina caprodes).* (2) *An Instance of Locality Memory in the Woodchuck.*

ELIZABETH M. DUNN (Nelson Morris Laboratory of Medical Research): *The Sensory Innervation of the Developing Hind Leg of Rana pipiens.*

F. L. LANDACRE (Ohio State University): *A Comparison of the Cerebral Ganglia of Ameiurus, Lepidosteus and Rana in Embryonic Stages.*

W. B. WHERRY (introduced by H. McE. KNOWER): *Experimental Studies on Ameba.*

M. A. BRANNON (University of North Dakota): *An Examination of the Conditions of Life in Devils Lake.*

This report deals with experiments in acclimatizing fish at the North Dakota Biological Station, on the shores of Devils Lake, North Dakota. The experiments extended over a period of four summer seasons. The large-mouthed black bass, the sucker, bullhead, pickerel, yellow perch, steel head trout and rainbow trout, furnished the material for the experimental work. Their ages varied from fish that were only a few months of age to those that were several years old. The Devils Lake waters are about one and two hundredths per cent. saline with the three salts, sodium sulphate, magnesium sulphate and sodium chloride, representing the major part of the saline material in the water. None of these salts, in the percentage existing in Devils Lake waters, are toxic for fish, hence it seemed probable that it was a physical rather than a chemical condition which was inhibiting the fish life which I placed in the cultures of Devils Lake water. Proceeding on that hypothesis the fish were placed in waters that very gradually changed from the chemical composition of the sweet water, from which the fish came, to the percentage of salinity of that in Devils Lake.

The factors of heat and gas composition were found very important, as shown from the readings which were determined during the progress of the experiments.

Devils Lake was the home of millions of pickerel prior to the year 1888. Carloads were shipped away regularly each week during the winters when they were so abundant.

A series of dry years caused a lowering of the level in some fresh-water lakes formerly connected with Devils Lake. This in turn was followed by the drying up of the stream connecting Devils Lake with sweet water associates. These latter had served as breeding grounds for the pickerel which came in the autumn, like the anadromous fish to the ocean. They entered water that increased gradually in salinity. Having learned that this was the history of the former occupants of the lake the experiments of the North Dakota Biological Station were directed toward repeating artificially what had occurred in nature. Results have finally been obtained which are wholly successful. Evidences for this conclusion will be submitted in the complete discussion referred to in this abstract.

SERGIUS MORGULIS (Carnegie Nutrition Laboratory): (1) *The Influence of Protracted and Intermittent Fasting upon Growth.* (2) *The Nervous System and Regeneration.*

C. C. NUTTING (University of Iowa): *Can We get Together on the Nomenclature Question?*

The present situation is unsatisfactory, and a solution is greatly to be desired.

Points on which both parties are agreed: (1) That there should be definite laws of nomenclature, including priority. (2) That there should be a commission to interpret and administer these laws.

Position held by the International Commission on Zoological Nomenclature: (1) That no exception be allowed to the priority rule. (2) That no rule shall be modified except by unanimous vote of the commission. (3) That the commission be treated with the deference due an international court.

Position held by a large number of those who voted against the priority rule: (1) That there should be a reasonable "statute of limitation" by which names long in undisputed and general use should be excepted from priority rule. (2) That there should be an application of the principles of equity in special cases. (3) That a majority of the commission should have the power to propose changes in the rules of nomenclature, and to bring such changes to a vote by the International Commission. (4) That we retain the right of free criticism of the commission without being required to observe the etiquette supposed to govern international courts. The commission is the servant of its constituents the "common people" among the zoologists.

The present situation regarding the priority rule: (1) The commission "stands pat" in adhering to the position outlined above. (2) A majority of zoologists are opposed to the priority rule as administered. The commission has not secured the support of its constituency, and has no means of enforcing its decrees. There is a distinct tendency among working systematists to ignore the findings of the commission.

A tentative solution: (1) Adoption of a rule by which a two thirds majority of the commission can change any rule. (2) Recognition of the legal principles of (*a*) the statute of limitation and (*b*) the law of equity as applied to individual cases.

W. C. CURTIS,
Secretary

SOCIETIES AND ACADEMIES

THE SOCIETY OF RESEARCH WORKERS IN EXPERIMENTAL BIOLOGY

AT the meeting of this society held on December 18, 1912, at the University Club, Washington, D. C., Dr. William Salant, chief of the section of pharmacology, Bureau of Chemistry, U. S. Department of Agriculture, gave an exhaustive review of the literature on creatin and creatinine metabolism.

Especial stress was laid upon the elimination of creatin in various diseases affecting the muscles, the central nervous system and the liver.

The recent work of Mendel and his collaborators on the relation of carbohydrate metabolism to creatin, in which it was shown that a distinct relation probably exists between the formation of creatine and the amount of carbohydrates ingested, was discussed. In addition, the speaker gave a brief résumé of his own work on the influence of caffein on creatin and creatinine elimination, pointing out that under some conditions, such as starvation, caffein may cause a considerable increase in the output of creatine.

Other conditions affecting the elimination of creatine and creatinine such as temperature, the amount of age, the fate of ingested creatin and creatinine, and the metabolism of these substances in different animals, were dealt upon with some length.

LEWIS W. FETZER

SCIENCE

FRIDAY, FEBRUARY 21, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE STUDY OF MAN[1]

IN that most amusing and instructive dialogue, entitled "Theætetus," the author Plato makes Socrates enter into a discussion with the youth by offering help as a skillful midwife to deliver him of a true and logical answer to the puzzling question: What is knowledge? When the youth replies,

> According to my present notion, he who knows perceives what he knows, and therefore I should say that knowledge is perception,

Socrates proceeds—perhaps not altogether fairly—to identify his doctrine with the celebrated saying of Protagoras. This saying is about all we know of the positive teachings of him who was esteemed to be the founder of the Sophists. The proposition as expressed in the same Dialogue runs as follows:

> Man is the measure of all things; of that which is, how it is; of that which is not, how it is not.

Even in the time of Plato the Sophists had translated this proposition into the doctrine: For every person, that is true and real which appears so to him. From this doctrine it was no long step to the conclusion, that there is possible for man only a subjective and relative, not an objective and universal truth.

From the time of Protagoras to the present, the view of the nature, authority, and limits, of perception by the senses, which his celebrated *dictum* embodies, has been the chief source both of popular and of scientific and philosophical scepticism; while the resulting doctrine of the relativity of all human knowledge, in its most

[1] Address of the vice-president and chairman of Section H—Anthropology and Psychology—Cleveland, 1913.

essential features, is widely dominant in scientific circles at the present time. I propose, therefore, to make it the point of starting for the consideration of two problems: First, What have modern psychology and anthropology to say about this theory of sense-perception and its resulting or allied theory of knowledge? and, second, What results from the answer to the first question as bearing upon a correct view of the relations in which the work of psychology and philosophy—the study of man—stands to the work of the other positive sciences?

But before we even propose in more definite form these two problems, let us consider in a word our right to group psychology and anthropology together under the common term, "the study of man." That the two sciences have indeed some special relations as affiliated and mutually dependent and helpful branches of study, the very fact of this sectional meeting should seem to affirm. Indeed, so intimate are the relations between the two that there are points—and more than one of such points—where it is difficult to draw a line between them. If, for example, we speak of anthropology as inclusive of a wide range of sciences—physiology, ethnology, archeology, ethics, religion, "the rise of arts and science, and the history of civilization"—of which psychology is only one, we are met by the fact that psychology, too, has spread itself over the same territory, as affording feeding-ground for its insatiable appetite. Thus we have come to speak of physiological psychology, race psychology, the psychology of ethics, art and religion and of a so-called applied psychology, which undertakes to instruct teachers how to teach, doctors how to cure, lawyers how to examine witnesses, and even overwrought and neuropathic women how to control their eccentric and pathological tendencies.

Nor can we claim that psychology, as at present studied, confines itself to the mental or subjective side of man, while anthropology deals rather with the objective and with man's place in nature. For anthropology falls short of its highest mission and most valuable opportunity, if it does not itself make a study of the spiritual evolution of the race. (I do not, of course, employ the words "spiritual evolution" with any cant or even definitely religious significance.) Both psychology and anthropology fail of using the only method of rendering themselves scientific, if they do not proceed according to the lines marked out by the conception of development. But without further remark upon this subject, we may perhaps agree upon the conclusion that the one, psychology, is, for scientific purposes, best defined as the natural history of the individual mind, or soul; and the other, anthropology, as the natural history of the race.

Even this attempt to distinguish the two, when reflected upon from the modern scientific point of view, shows all the more clearly how intimate is the relation between them. The dependence of anthropology upon psychology, as one of the sciences which it must take into the account, is pretty generally conceded. But what is not so universally acknowledged is equally true. This is the dependence of psychology upon anthropology. No individual man can fulfil the obligation of the ancient motto, "Know thyself," without something approaching a scientific knowledge of the human species of which he is a member; of the acquired or inherent instincts, tendencies, inhibitions, naïve assumptions, emotional yearnings and strivings, which make up the greater portion of the influences controlling the so-called

nature, and natural history of the self. "Know thyself" means know thyself as a man, a member of the human race. And the natural history of the individual mind or soul, can not be described, much less explained, without interpreting it all in the light of what we have learned of the natural history of the race.

These remarks may suffice as introductory to an answer—confessedly fragmentary and full of assumptions which need proofs from sources lying outside our theme—to the two questions raised above. The first of these, you will remember, was this: What have modern psychology and anthropology to say about the view which identifies knowledge with sense-perception, and about its allied theory of knowledge?

If by perception by the senses we understand the mere fact that certain sensations form groups and sequences in consciousness, which have more or less of persistence and regularity, the banter of the wise Socrates as addressed to the youthful Theætetus is not inappropriate in our own day:

> I say nothing against his doctrine, that what appears to each one to be, really is to each one, but I wonder that he did not begin his great work on Truth with a declaration that a pig or a dog-faced baboon or some other strange monster which has sensation, is the measure of all things; then, when we were reverencing him as a god, he might have condescended to inform us that he was no wiser than a tadpole and did not even aspire to be a man—would not this have produced an overpowering effect? For if truth is only sensation, and one man's discernment is as good as another's, and no man has any superior right to determine whether the opinion of any other is true or false, but each man, as we have several times repeated, is to himself the sole judge, and everything that he judges is true and right, why should Protagoras himself be preferred to the place of instruction, and deserve to be well paid, and we poor ignoramuses have to go to him, if each one is the measure of his own wisdom?

Even if we say, I do not mean the sensations of a tadpole, or even of a dog-faced baboon, but the sensations of a man, we do not establish in perception by the senses alone a ground for science. The only way we can know what the baboon actually sees, or otherwise perceives through *his* senses, is by the use of *our* powers of perception as applied to the behavior of the baboon. Our claim to superiority over the baboon, even if we are descended from him in more or less direct line, is based upon the confidence that our perceptions, as forming a ground for a scientific knowledge of things, and perhaps for a theory of the universe, are more trustworthy and comprehensive than are his. The old-fashioned way of putting this truth was not so bad after all: Man may be an animal; indeed, he undoubtedly is an animal; but man is a *rational* animal.

Psychology, with its recent more subtle analyses, as made possible by the experimental method, has made it perfectly clear that sense-perception in the case of the human individual is an exceedingly complex development, involving all man's natural and acquired capacities and forms of functioning. Into every act of the senses which gives us intimations, or assured knowledge, of real existences and actual happenings, there enter many instinctive or acquired faiths, leaps to judgment or more slowly formed inferences, emotional factors expressive of doubt, or certainty, or negation, habits favoring or prejudiced against this or that conclusion, fleeting or more fixed associated images of memory or of fancy, and formal or regulating principles, the so-called categories or "innate ideas" of the earlier philosophy. But above all, if the process of sense-perception terminates in conviction of the reality of the object perceived, or the actuality of the event observed, then this object, or those things concerned in the event, are made the centers of forces that justify us in

giving them a place in a world outside of our own conscious selves. In other words: They are endowed with a will of their own, a will that wills not as we will. That all this is a species of the personifying of things, I have myself no manner of doubt.

But the knowledge of things as gained by the senses in the case of every individual, can not separate itself from the knowledge gained in the same way by the race of which the individual is a member. The motor reactions underlying the faiths and assumptions, the accumulated contributions of the faculties of memory and imagination, as all these are incorporated into the central nervous system, are matters of the development of the race. What even the average school-boy sees and hears, as well as thinks about and reads into his experience with the senses, is not precisely the same as that of the boy in ancient Egypt or Greece, or even the boy among the savage tribes of our own day. Are not the sense-perceptions of the believer in spiritualistic phenomena and in Christian science different from those of the sceptic and disbeliever, to-day, even when we place them in as nearly as possible identical relations to the object to be perceived? Here, then, is where anthropology becomes a valuable adjunct to any theory of sense-perception.

As to the theory of the relativity of all knowledge as stimulated by and embodied in the maxim that man is the measure of all things, its falsity or truthfulness depends entirely upon what is meant by the word "relativity." In the Theætetus Plato makes Protagoras—we do not know with what right—base his doctrine on the philosophy of Heracleitus. Now, no other philosopher of antiquity has been of late so re-habilitated in reputation and so clothed with honor as has the Ephesian Heracleitus. He was the founder of natural philosophy among the Greeks, the leader of the physicists of the fifth century B.C.

> So powerfully impressed was he with the ceaseless change of things, the transitoriness of all the particular, that he sees in it the most universal law of the world, and can only regard the cosmos as being involved in continual change, and transposed into perpetually new shapes. All things are in constant flux; nothing has permanence.

If by the relativity of knowledge, as established by the psychological and anthropological study of man, we mean that no other knowledge is possible for human beings than that which comes into relation with human faculties for knowledge, there can be no objection to, or denial of, so obvious a truth. All man's knowledge of mankind and of the rest of the world is *human* knowledge and comes under the limitations and conditions of all human knowledge. Man's fields of knowledge have boundaries; and what he wins from these must be by patient and skillful using of the means of culture, his own senses and intellect applied to the data of his own experience.

If by the relativity of knowledge we mean also to assert that all knowing is an actual relating, an exercise of the function of relating activity, and that all things known are known as related to other things, we are only stating undoubted psychological facts. These facts are of fundamental importance in our interpretation of the true meaning of the saying, "Man is the measure of all things." Still further, if we mean that all advance in knowledge, on the part of the individual and of the race, is related to the past stages and achievements of knowing faculty, then, too, we are stating a truth on which psychology and anthropology may cordially unite. But when by the relativity of all knowledge it is meant to imply a complete distrust of

man's ability to discover and prove anything about the reality of the world in which he lives, or to apprehend with assurance of conviction what is now actually taking place within or without, or what has actually taken place in the past, we press our scepticism and its resulting agnosticism far beyond the limits warranted by a proper understanding of the Protagorean maxim. Man is indeed the measure of all things, *i. e.*, so far as things really exist for him or actually happen in the real world which environs his existence.

So, then, he who takes his attitude toward his own science, or toward the practical life, from that study of man in which psychology and anthropology may cheerfully concur, will undoubtedly hold to a certain theory of the relativity of all knowledge. This theory will lead him to say: There are a few things of which I have perfectly certain and absolutely sure knowledge. There are some more—perhaps, many more—of which I am reasonably sure; and the surer, the more I grow in knowledge. There are yet more of which I am in doubt, and about which I am holding my mind in suspense and open to the conviction which follows upon trustworthy and sufficient evidence. But the things I do not know are like a vast and limitless sea—to borrow an illustration from the philosophy of Kant—on the bosom of which lies my little island of knowledge and opinion. How far future explorers in all branches of science may sail that boundless ocean, or what other islands they may discover or treasures bring up from its depths, I am not going dogmatically to pronounce. That would be to assume more, in view of our present relations to the past and the future of science, than any one is justified in assuming. Besides as a student of man from the anthropological point of view, I am taught to be cautiously agnostic in this regard.

But when any one says of himself, I know absolutely nothing about myself, or about things, or about the transactions between myself and things, or among things, which I am confident have a corresponding reality, he appears more modest with reference to his own powers than the doctrine of the relativity of knowledge requires that he should be. And when he goes on to say, You, too, know nothing, and can know nothing as to what is real and actual, he is not altogether polite, not to say flattering, toward a fellow aspirant for knowledge. But when he proceeds with the declaration: Neither I, nor you, nor anybody, really knows anything, or ever can know anything, about the real world and about the events assumed actually to occur in this world, his agnosticism has indeed taken a suicidal turn. For, surely such an agnostic knows that he does not know, and yet somehow exists in a world about which he and all others are in this state of perpetual and incurable ignorance; and this would seem to imply that I and others without number, in the most important respects like him, do also exist in an unknowable but undoubtedly actually existent world. It seems then that the complete agnostic is the man who is very sure that he can vindicate his agnosticism by appeal to some actual, objective standard of judgment which he and others possess in common. That is to say, while arguing from his doctrine that man is the measure of all things to the conclusion that no knowledge is possible, he involves the other very important conclusion or assumption that the world is full of actually existent rational beings, besides and outside of himself.

The importance of considerations like those just announced is greatly increased

when we apply them to the relations in which the study of man stands to that kind of knowledge which is embodied in the so-called positive sciences. The term science is properly applied to any grouping of knowledges to which has been given systematic form, and which has been based upon evidence that admits of being reviewed, estimated and, if possible, submitted to some kind of testing by comparison with other similar experiences. Thus science does not essentially differ from what we call ordinary knowledge; and when we extend the maxim which makes man the measure of all things to the positive sciences, we do not reduce their proof, their claims to acceptance as true pictures of reality, to the testimony solely of immediate sense-perception. No science consists solely or chiefly of data that can be seen, heard, handled, tasted or smelled. But all science, like all knowledge, whether we dignify it with the name of science, or not, is either envisaged or implied in data of concrete and individual experiences. And it is man's reasoning faculties which make explicit what is thus implied. For the method of all science is rationalistic, in the broad meaning of the term. In this work of rationalizing, the imagination, the faiths of reason, and even the emotional attitudes of the human mind toward truth and reality, play an important part. In every individual case, but more emphatically in the case of the race in general, every particular science is a development, an ever growing and never completed achievement of the human mind. And to this development, hypothesis, theory, deduction from known or assumed principles, are all as important and indispensable as is the correct and guarded use of the senses in perception.

In the day when our maxim was first enunciated, there was no positive science of the physical, chemical or historical sort. There was much acute observation of phenomena, especially in the sphere of the moral, political and social life of man. The ancient Greek maxims for the regulation of the conduct of life have rarely or never been surpassed. The pragmatism of that day was in important respects, both more dignified and more satisfactory than the pragmatism of the present day. The Sophists were pragmatists of the most accomplished rank. But neither ancient nor modern pragmatism can ever give us science, or account for the existence, or the estimate of the values of science, properly so called. As a commentator on this very Dialogue of Plato has said:

> The want of the Greek mind in the fourth century before Christ was not another theory of rest or motion, of being or atoms, but rather a philosophy which could free the mind from the power of abstractions and alternatives, and show how far rest and how far motion, how far the universal principle of being, and the multitudinous principle of atoms, entered into the composition of the world; which could distinguish between the true and false analogy, and allow the negative as well as the positive, a place in human thought.

It is only in comparatively recent times, however, that the different sciences of external nature and of man have devoted themselves intelligently and deliberately to the supply of that which was the want of the ancient Greek world of observation and of thought. The Greeks, for example, observed that a vacuum was created by the suction of a piston above the water in a pump. But the dictum, "Nature abhors a vacuum," was regarded as a sufficient explanation of the fact for more than two thousand years, before it was observed in jest by Galileo, that nature did not abhor a vacuum beyond ten meters. But Toricelli was the first really to explain the phenomenon by bringing it under the law of gravitation. Aristotle had observed—

and how many in our scientific age have observed for themselves?—that the sunlight, when passed through a small square hole, gives a round instead of a square image; but he explained the fact simply by saying that sunlight has a circular nature. It was centuries before astronomy established the true explanation in the fact that the sun itself is a circular body.

It was a combination of the principle sounded like a trumpet-call by Newton—"Abandon substantial forms and occult qualities and reduce natural phenomena to natural laws"—with the modification and improvement of the Baconian method of experimental induction which introduced the new era in the positive sciences of external nature. By following these principles man has made of himself a more accurate and faithful measure of all things; of that which is, how it is; and of that which is not, how it is not. But he still needs as much as ever the further study of himself, as an individual and as a race, in order so to supplement, modify, adapt and otherwise improve the principle, that all the various classes of that accepted and certified knowledge which he calls by the name of science, may benefit by this study.

I come, therefore, at once to what is the main purpose of this paper. It was announced in the second of the questions proposed at the beginning. This question concerns the more fundamental of those relations in which the study of man stands to all the other positive sciences. Generalizing these relations, I will say that the study of man as the measure of all things is entitled to set forth and expound (1) the method of science; (2) the limitations of science; (3) the ideals of science. And what it is entitled to do for science in general, it may properly suggest as desirable and true for each one of the particular sciences.

Intelligently comprehended and faithfully interpreted, the study of man, the measurer, is the only way to find out how his measuring-rod ought to be applied to the different objects which come before him in the different classes of his varied experience. Every positive science, and we might almost say every subdivision of such science, has its special, most satisfactory mode of procedure in the search for truth. That this is of necessity so was known to Aristotle as distinctly as it is known to any modern man of science. Indeed, the principle was never better stated than it was by him in the first book of the "Nichomachean Ethics." There the great Greek thinker holds that the matter of a science, *i. e.*, the facts or conceptions with which it deals, must determine its method or form, according as they admit of being stated with more or less "precision" (Ἀκρίβεια). But the Greek word which I have imperfectly translated by the English word "precision" means in Aristotle's use of it a combination of mathematical exactness, metaphysical subtlety, minuteness of detail and definiteness of assertion. And as applied to the form of science, or study of one aspect of man, namely, the ethical, which he is proposing to consider, he distinctly states that mathematical exactness is quite unsuited to ethics; that we must not expect too much subtlety, and that too much detail is to be avoided. In this respect his view is more liberal and more true to the nature, limitations and ideals of human science than is that of Sir Isaac Newton when he insists that all "natural phenomena," including the biological, shall be reduced to "mathematical laws." For every step in the evolution of science, as subjected to the conclusions derived from a study of man,

shows that a knowledge of qualities and relations of quality, many of which do not admit of a reduction to mathematical laws, is an indispensable part of all the sciences which deal with natural phenomena.

Every particular science, and, if you please, every form of experiment in each one of them all, should be allowed to determine its own method in the details of its observations, testing the alleged facts, and obvious conclusions from the facts. There is really no reason for assuming a sort of holy mystery about scientific method in general, or about any particular scientific method. *Method is any means of arriving at the truth of reality.* The greater truths of science, as well as of religion, have always been revealed to gifted—and for my part I am willing to say, inspired—minds, as flashes of intuition, fortunate guesses, hypotheses which as yet awaited verification but shone with that light which announces the clearer vision of the approaching day. I have always had a sneaking sympathy with that schoolboy who, when he came home from school snivelling because he could not do the sums in mental arithmetic set by his teacher, and his mother reminded him that, of course, he had been taught at home the correct answer to them all, replied: "Yes, of course, I know what the answer is, but I can't get the method."

While, then, we admit the right and repose the obligation to any special form of technique, as a matter for the particular sciences to decide for themselves, we still insist that the nature of the human mind and of its development in the individual and in the race is the source of all the experience which determines the successes and the failures in the use of every particular method in each of the particular sciences.

Still more definite but brief statements with regard to the doctrine of method which the relativity of all knowledge makes imperative would seem in place at this point. If man is to take even his preliminary measurement of things, of that which is, how it is, and of that which is not, how it is not, by sense-perception, he must use trained senses with inexhaustible patience, and with freedom from prejudice and professional pride and ambition. Some years ago the retiring president of the Association of American Naturalists, in his address at the annual banquet, related this recent experience of his own. He had written to a considerable number of the leading biologists in the country, asking that they should give him just the bare facts as they had observed them, and with no admixture of their own views in explanation, upon a certain matter which he was engaged in investigating. "Even so," said this scientific observer, "I could not get the simple unsophisticated facts reported." How many biologists and physiologists in the world at the present time, whatever confidence they may have in the ability and sincerity as an observer of Dr. Bastian, are sure he is giving them just an unprejudiced statement of the facts in proof of his theory of spontaneous generation?

The psychological study of sense-perception, as strengthened by the anthropological study of man's progress in knowledge, shows with undoubted clearness, not only that the details of every man's sense-perceptions are his very own and quite unique, but also that the influence of habit, expectation and interest, contributes largely to what the senses are bound to perceive. But the true doctrine of scientific method which follows from the study of man as a measurer of things by his senses, logically followed, does not land us in an absolute distrust of the senses, in a gulf of scepti-

cism and agnosticism with regard to all human knowledge. The rather should this study serve as a reminder, how uncertain and slow is the laying of solid foundations for the building of the temple of science; but also, how solid those foundations, when well laid, actually are; and how noble the temple which man is erecting toward the skies, on these same foundations.

Among a certain class of psychologists and philosophers—I am ashamed to confess it—there has been much deprecating and even sneering, directed toward the stern control of the logical faculties in the discovery and proof of the nature of reality. "The will to believe," or the leap of emotion to conclusions affecting the nature of reality, has been attractively offered, and far too freely accepted, as a substitute in science as well as in religion, for the use of reason under the control of reason's lawful working. But the study of man utters a loud warning against all this. Even a truly scientific mind may express itself and its findings in an alluring rhetorical style. But such a style can never be safely trusted as evidence for, however effective it may prove in exposition of, the truths of either common life or science and philosophy. Logic may be fervid, but it must still remain logic, if it is to be offered in proof of truth. On the one hand, it is true that a purely logical or dialectical construction of scientific theory, after the Platonic or the Hegelian method, when it cuts itself from the bonds which tie it down to concrete facts of more or less nearly universal experience, is not man's way to measure most faithfully the truth of things. But, on the other hand, it is equally the fact that only by the use of the intellect, the logical or so-called dialectical faculty, can the truth be explicated and interpreted as it lies hidden in the facts. The history of scientific progress shows beyond all question, that it is not great collectors of facts, but great thinkers reasoning concerning the meaning of the facts, who have most contributed to this progress.

An additional consideration of no small importance which is made quite clear by the natural history of the individual mind, as well as by the natural history of the race, is this: Knowledge is not only a matter of development, of progressive achievement, in the individual and in the race; it is also a matter of degrees. Any body of knowledge, no matter how strictly it may be entitled to the term science, will necessarily consist of propositions that are made with quite different degrees of assurance. This truth should always be frankly acknowledged in the methodical procedure of every science. Every positive science will, of course, aim to have its different conceptions, so-called laws, and fundamental principles hang well together. It will also attempt to fortify itself by coming into relations of mutual support with the other most nearly allied sciences. It will, above all, test its own conclusions by the amount of agreement which its own best students and trained experts have been able to reach as exponents of the best intellects of the race, in their prolonged and unprejudiced application to the problem of interpreting the experience of the race. But every science will also remember that the very method of science, as inexorably fixed by the nature of man's intellectual processes, makes it necessary to discriminate different degrees of knowledge, with shifting degrees of certainty and changing claims to importance, as the knowledge of the race advances in clearness and comprehension.

In this connection it is worth while simply to call attention to the fact that the mental attitudes of scepticism, criticism and agnosticism are indispensable and val-

uable factors in all scientific method. Every investigator who attempts to employ the proper method in measuring the things of his special science, is bound to be, always a critic, often a sceptic, oftener still an agnostic. But every investigator is also yet more imperatively bound to be critical, sceptical, agnostic, in right directions; and toward the different conventional opinions, and accepted conceptions and laws constituting the body of that science, in accordance with the varying degrees of evidence and proof.

One thing more on this point. The study of man in any broad and sympathetic way shows us unmistakably that an essential element in all scientific method is a certain indestructible confidence of reason in its own ability, by repeated trials and successive approaches, to reach the truth of things. Man as the measurer of all things is somewhat like those conceited tailors to whom we are sometimes compelled to resort in our efforts to get a perfectly fitting suit of clothes. He is always trying on the coat and altering it, until he has reached the limit of the cloth he has sold us; and then we must be contented with his assurance that it fits us perfectly, while in our secret thought we are troubled with the suspicion that it fits us only fairly well. At any rate, for the present the process of fitting can no further go. At the annual meeting of the British Association in 1904, there were two things, according to the reports in the newspapers, on which those in attendance were all agreed. One of these was that they had never before had quite so fine a time socially; the other was, that in none of the branches of the association was there any one where all the members were in agreement upon any one thing.

Cast a glance over the history of science in general, or over the history of any one of the particular sciences. Those who scorn philosophy under the pseudonym metaphysics are fond of making merry over the persistent and universal lack of agreement on any one point, of the philosophers from the beginning of reflective thinking until the present time. But the simple fact of history is that the more fundamental tenets of philosophy as held by the different schools have been far less subject to change than have the important conceptions and so-called laws of the particular sciences. What enormous changes have taken place in all these sciences since the improved methods of studying their data have gained general acceptance and been put into general practise! Each one of these sciences is accustomed to boast: In the last half century or less we have made all things new. And with regard to the future of science the words of Scripture are scarcely too strong to describe its apocalyptic vision:

> And I saw a new heaven and a new earth; for the first heaven and the first earth are passed away.

All man's voyage on the sea of knowledge, for the discovery, mapping out and exploiting of the new domains of science, is strewn with the wrecks of voyagers in the distant or near past. Never before were so many vagaries and visionary schemes and unproved hypotheses demanding attention and credence. But never before was the fleet of voyagers so numerous, so competent, so sound, so sure of its future, as at the present time. How can such things be? How can the measurer always be making such misfits, spoiling so much cloth, and annoying so much his patient, trustful customers, and yet retain his own immeasurable self-conceit? There are two reasons which establish the sufficient answer to this question. One of these is the indestructible faith of human reason

in itself. It hesitates, it stumbles and makes mistakes and either confesses and corrects or stubbornly adheres to them; but it never despairs or is utterly confounded. The other reason is this: History shows that this confidence is more and more, in fact, justifying itself. All progress in knowledge depends ultimately for its justification on this self-confidence of human reason; but all actual progress in knowledge is a further justification, in fact, of the confidence on which it depends. Man has faith in himself to know; in exercise of this faith, he actually attains higher and higher degrees of knowledge. While, then, constant criticism, frequent scepticism, much rather persistent agnosticism, are attitudes of the human mind toward reality, which should always characterize the method of science; scornful criticism, despairing scepticism, universal agnosticism, are essentially antagonistic to the true spirit and hopeful method of science. And those who cherish such views of the relativity of all knowledge are dissenters from the one form of faith which underlies all particular forms of faith, intellectual, social, religious. An ever present and essential feature of man's rational being is rational faith, or reason's own confidence in itself as the organon of truth.

While, then, each particular science has its own special methods of procedure in the discovery and testing of its own conceptions and laws, there is a certain universal method; or, the rather, there are certain general considerations touching a universal method, which all must observe. Three rules of method, confirmed by the psychological and anthropological study of man, provide for the patient, unprejudiced use of perception, by way of self-consciousness and through the sense, of the facts; the consistent and controlled use of the logical faculties in the interpretation and explanation of these facts; and a justifiable faith in reason as opposed to the positions of a despairing agnosticism. It is not the ancient Sophistical or the modern pragmatic interpretation of the Protagorean maxim, Man is measure of all things; of that which is, how it is; and of that which is not, how it is not, that can guide us into the safe and fruitful method to be pursued by the positive sciences. But, then, it is a comfort to know that even those devotees of these sciences who confess a faith in this interpretation, never take their faith with any large amount of practical seriousness.

A second important way in which the study of man is related to all the sciences concerns the limitations of all science. We are all familiar with the many mistaken predictions as to the limitations of particular sciences which have been made in a merely empirical way. In the "Memorabilia" Xenophon makes Socrates remark upon the impiety of men in trying to describe how the gods made the world of things; since all knowledge of this sort is forever beyond the limits of human faculty. In the "Timæus," however, Plato makes Socrates indulge in the wildest speculations, in dreams exceeding those of the poet and resembling those of the madhouse, as to how this same world may have been made. No sane student of science now believes that the actual limitations of science are of either sort—either that asserted in the "Memorabilia" or that notably transcended in the "Timæus." It is the business of science—a matter of obligation rather than a mark of impiety—to know how the natural universe was made and is being made. But when the mind assumes to dream its way into this kind of knowledge, it grossly violates the laws which inexorably fix for all time its impassable limitations. Within the fields of science itself there are constantly occurring

dogmatic statements as to what is intrinsically possible or forever impossible, for the endeavors of human knowledge. Have we not been told that the distances of the fixed stars could never be measured; that the achromatism of lenses could not be carried beyond a certain point, which has already been considerably surpassed; that steamships could never cross the ocean and airships never sail the air, in safety; that synthetic chemistry in the laboratory could never simulate the products of animal and vegetable organisms; that the speed of the nerve current could never be measured, etc., etc.

But what does all this purely empirical way of fixing the limitations of science amount to in the respect of justifying our attempts to regulate the hopeless waste of man's endeavors to know the forever unknowable? Even to-day we may be just as ignorantly—with an ignorance even made more exasperating by the fact that it is so often the outgrowth of our conceit of knowledge—denying the alleged facts of telepathy as was Newton when he refused to explain gravitation as *actio distans*. But whether this or that particular prediction come true or not, this is not the point. The point is this: that by the study of man we are able to fix certain limitations to all science which are inherent in the very nature of man himself and in his relations to that larger nature of which he is a part. It is to the consideration of this sort of limitations that we now devote a moment's attention.

That the senses, from the nature of the psychophysical organism which they serve, are limited in capacity, is a matter of course. Their anatomical structure and their forms of functioning, physiologically considered, require that the range and accuracy of their observation should be confined within certain limits, both of space and of time. In the eye, the size of the rods and cones; in the ear, the physical construction of the bony and muscular parts of the cochlea; in the skin, the frequency and arrangement of the temperature spots and the pressure spots—all these special limitations of the organism are limits to the measuring power of human sense-perception. Let these physical limitations be changed, either in the direction of improvement or of depreciation, and there would still be similar limitations inherent in the organic structure of the race, and varying with different individual members of the race. In all the various realms of sense-perception, there will always be that which lies beyond, and which can only be conjectured, or at best reasonably inferred, but which can never become immediately perceived by human senses. Surrounding the expanding island of the visible world will be the boundless sea of the invisible; of that which can be touched and handled, the many things that no skin is sensitive enough to feel and that no hand can grasp.

These limitations of the senses set their limitations to the pictorial imagination, or imaging faculty, as distinguished from what logicians have been accustomed to call "pure thought." How things would look, the like of which no eye has ever seen; how things would sound, the like of which no ear has ever heard, will remain questions to which the experience of measuring all things with the senses can give no answer.

But there are other irremovable limitations to human knowledge which are even more important, although more difficult to make obvious. These are limitations inherent in the very constitution of the intellectual powers. The intelligence of man has its own way of working, its laws of behavior, its inescapable modes of operation, to whatever subject it may be applied.

The attempt has indeed been made to account for forms, laws, innate ideas—call them what you will—as the results of a process of evolution. In my judgment, such an attempt must always remain a complete failure. The so-called primitive man in the long gone-by ages reasoned in substantially the same way as that in which the German professor of physics or the American financier or politician reasons to-day. Nor does it appear that the savage peoples of the present time have essentially different minds from our own, or are intrinsically inferior in the acuteness, speed and accuracy with which they reason. Their limitations, as compared with ours, consist chiefly, if not wholly, in the extent of the accumulations of experience with a wider world of things and of men, which lie behind them in history and which constitute their present environment. But we as well as they, and no less truly than they, when we measure things by minding them, know them only according to the formal limitations of our own minds. These limitations concern the comprehensiveness, the certainty, the range, both toward the large and toward the small, the simple and the complicated. The infinite and the infinitesimal may be symbolized and carried as symbols through complex mathematical calculations; but they can never be envisaged by the senses or comprehended by the intellect.

This sort of irremovable limitations surround all the growth and all the achievements of the particular sciences, and might be set forth at any length in the discussion of the categories of science. But such a discussion would be too technical for our present purpose and would take us much too far afield.

Some illustration of what is meant will serve our present purpose. The history of the growth of science for two thousand years shows many curious attempts to dispense with the obligations put upon the human intellect by the so-called categories, or fundamental and irreducible forms of conceiving of reality, that seem to flow from the very nature of the intellect itself. This effort among the students of physics is particularly insistent and even violent at the present time. But it is just as certainly doomed to failure now as it has ever been. For example, we are treated to a science of physics which would do away with the realistic conceptions of substance and cause, and would substitute for them the more impressionistic and phenomenal conceptions of motion and change. For do we not, with our senses, which are the measure of all things, of that which is, how it is, and of that which is not, how it is not, become actually aware of motions and of changes? But who ever saw, heard, felt, smelled or tasted, of a substance or a cause, in the metaphysical meaning of these words? Go to, then! Let us banish metaphysics and confine our scientific measurements to what the senses can actually perceive. But the conception of motion without this adjunct or underlying conception of something real that actually moves, or the conception of a change that is not caused, or compelled by, or otherwise to be attributed to, some actually existent agent, is a ghostly and intolerable conception. And the world in which relations of motion are supposed to be the sole topic for scientific investigation, is a ghostly and not a real world. But we may always observe by reading between the lines that the "scientist," because he is also a man, and is under the limitations of human intellect, has allowed to sneak in at the back door the very conceptions which he has more or less impolitely dismissed from the front. He must have a "that-which" as substance for his observed motions and as a point of

attachment for his observed changes. For reality is not made up of modern scientific, any more than of ancient philosophical, abstractions. It is, the rather, a theater in which real things are always actually doing something to one another, and in which each one is having something done to itself. There is nothing which the student of physical science more needs to learn from the study of man than that he himself is of necessity a metaphysician, and can only choose between some wisely and well thought-out metaphysical views, and a naïve, crude and misleading metaphysics of his own uninstructed self.

But the final question respecting the limitations of science as they are expounded by the study of man is this: Are they limitations of ignorance or limitations of knowledge? In other words, because there are inherent and inescapable limitations to the human intellect, are we to conclude that man as the measure of all things can really know nothing, just that it is and how it is, or are we to conclude that his knowledge, although never complete and all-comprehensive, is nevertheless knowledge indeed? And by "knowledge indeed" we mean that the real world and its actual happenings are in fact, progressively being more largely and accurately known by the combined achievements of the race? The proof of this faith, if there be proof, belongs to a department of philosophy which we are accustomed to call epistemology or theory of knowledge. In this connection I am only expressing my faith when I say that it is the same as the faith of the race.

Finally, the study of man is entitled to say what the true and worthy ideals of science are. For the scientific mind, the tenets of modern pragmatism with respect to the nature and meaning of truth can never be permanently satisfying. For science, knowledge has more than a merely practical value, and its tests are something more, and different from the mere success of its practical working. For science, knowledge has an ideal value. We are wont to express this by speaking of the worth of science for science's own sake. But the better, because the truer way to express this ideal is to say that knowledge as knowledge, and science as science, has value for man's sake. And this is because man's mind craves for, feeds upon, finds its satisfaction, uplift and refinement in, the growth of knowledge. To the human mind, or spirit, when it awakens to a realization of its call and its obligation to realize its own higher forms of privilege, and to improve its best opportunity, science affords a satisfaction that has a value of its own.

This is not to say that science has not contributed, and is not bound and glad to contribute, to the so-called practical and utilitarian in the life of man. Chemistry is not pursued with eagerness and satisfaction, and almost religious awe before the mystery of material existence, as a purely mercantile affair. But modern chemistry is transforming almost every branch of modern industry to the great practical benefit of mankind. Modern physics is not cultivated as the servant of the U. S. Steel Corporation, or the General Electric, or the Mercantile Marine monopolies. But the founders and promoters of these corporations owe every dollar of their legitimate earnings or of their graft, and the public owe all the material benefits which have fallen to them from these corporations, chiefly to modern physics.

The satisfaction of man's rational aspiration for knowledge is not, however, the only ideal which the study of man recommends for confidence and intelligent pursuit, to the other sciences. Every science,

no matter how seemingly remote from current human interests, and from man's daily life, may reasonably cherish a spirit of devotion to the social ideal. In educational circles there is just now great debate over the comparative values of the studies called abstract and those called practical, as constituting a preparation for the duties and responsibilities of "real" life. While admitting the reasonableness of this distinction and the value of certain proposals to alter the disposal of time and attention to be allotted by the average man to the two, we wish now to insist upon the thought that no form of science need be pursued, or ought to be pursued, without regard to the relation in which its pursuit stands to the social ideal. The pursuit of knowledge for knowledge's sake is itself a moral benefit to the normal man. And you can never bring about the social ideal, or advance far toward it, without discipline in the pursuit of knowledge. One of the ideals which science prizes and promotes is the ideal of a society, and finally of a race, which is so disciplined in knowledge that it may know how to be wise and upright in conduct. For, although such discipline is not the whole of what contributes to the moral and religious uplift of the race, without such discipline moral and religious progress is impossible for the race.

Hovering over all like a vast but glorious cloud that is being illumined, through the rising mists, by the rising sun, is the ideal to which the combined work of all the sciences is being directed for its better discovery and interpretation, the ideal of a universal order which has at its core, and through all its historical evolution, the unity due to rational mind. This conception in its modern outlines has been won by the toil of thousands of observers and thinkers, and slowly expanded and guaranteed, as it were, by the experience of the race. It is confessedly incomplete; perhaps it will always remain incomplete. For reality itself is no closed and once-for-all finished affair. But that the world is a realization in time and space of some such ideal as science has built up—an ideal unity of order, beauty and meaning—this is the growing conviction upon which the particular sciences, from their different points of view, and by their different methods, have been converging.

I must ask your further indulgence while I close this paper—already prolonged to an excessive length—in a fashion somewhat sermonesque, *i. e.*, with two practical and hortatory applications.

This view of man as the measure of all things calls upon those who engage in the scientific study of man, whether from the psychological or the anthropological point of view, for comprehensiveness and catholicity. All the other sciences are becoming more definitely tributary to the study of man. His marvellously complex and delicate organism traces its history through indefinite ages of evolution to an unknown and probably undiscoverable past. The description of this organism requires the combined results of the physico-chemical and biological sciences. What we call his mental and social nature and development enlists the efforts of the whole round of the psychological and historical sciences. But we are not ready for a complete and just estimate of the capacity of man as the measurer of all things until we have studied him as a speaking animal, a being with moral, artistic and religious ideals; and with a certain limited though genuine capacity for a self-controlled development in pursuit of these ideals. In a word, both psychology and anthropology are under the obligation to extend their studies, in the interests of comprehensiveness and catholicity, so as the better to understand and

master the spiritual nature and the spiritual development of the individual and of the race.

And, finally, our view of man as the measure of all things is an exhortation to an increase of sympathy and of sympathetic cooperation among all the different sciences. Of the particular sciences and their subordinate branches and subdivisions, there is an ever-increasing number. But their aim is one aim; and in the pursuit of this aim they should be as brethren dwelling together in a spirit of friendly criticism and also of friendly unity. The aim of all human science is the better to understand man by himself, and the greater nature which environs him; and the better to adjust himself to this greater nature, in the pursuit of his economic, social, artistic and religious ideals.

I venture to close with the words which Plato puts into the mouth of Socrates as he closes his conversation with Theætetus:

> But if, Theætetus, you have or wish to have any more embryo thoughts, they will be all the better for the present investigation; and if you have none, you will be soberer and humbler and gentler to other men, not fancying that you know what you do not know. These are the limits of my art; I can no further go; nor do I know aught of the things which great and famous men know or have known in this or former ages. The office of a midwife I, like my mother, have received from God; she delivered women, and I deliver men; but they must be young and noble and fair.

George Trumbull Ladd

PLEISTOCENE GEOLOGY OF NEW YORK STATE. II

LAKES

Glacial Lakes: Occurrence.—The term "glacial" is used by the writer to include only lakes which existed by virtue of a glacier ice barrier. The lakes and lakelets now existing and called "glacial" by some authors should be discriminated mostly as morainal or drift-barrier lakes.

The conditions necessary for a glacial lake are a valley or depression sloping toward and blocked by the ice front. These conditions were fulfilled in New York on so large a scale, in area and time, that the state, it is confidently believed, held the largest number and the most remarkable succession, with varied outflow, of glacial lakes of any district in the world. The reason for this superiority is found in the peculiar topography of the western part of the state. In the great Ontario-Erie basin we have a broad depression with its lowest passes on the east and west, and with a deeply trenched southern slope where lie the parallel valleys of the Finger lakes.

The only glacial lakes of which clear evidence is preserved are those which lay against the receding front of the latest ice sheet. But it should be clearly understood that every ice sheet which transgressed the state blocked the waters both during its advance and its recession.

We do not know what portions of the Valley-Heads moraine, which now constitutes the divide and forms the south limits of the basin, were left there by Prewisconsin ice sheets, but we may be quite sure that the lakes during the advance of even the last glacier were somewhat different in dimensions and relations from those of the ice recession, which are the subject of our field study. We may also be sure that the earliest ice invasion found the series of parallel valleys with fairly mature and graded forms, and open clear through to their heads, and the larger ones heading in Pennsylvania. Those earliest ice-impounded lakes must have been longer and deeper in the valleys than the lakes of later episodes, when the valleys had become more or less occupied by glacial and lake deposits. The lacustrine conditions of the episodes antedating the Laurentian ice re-

treat are as yet a matter of interesting speculation. One further difference may be noted between the ice-advance and the ice-recession lakes. The primitive lakes of the ice advance were the lowest in altitude and the most northerly in location and with the lowest outlets. As the ice advanced and closed the outlets the waters were lifted to higher levels and pushed southward. The last lakes of the ice advance being in the heads of the valleys were the smallest, the highest, the most detached and most southerly. The lakes of ice-front recession had precisely the opposite history.

Erosional Work.—The lake features that are preserved for our study may be discriminated as erosional and constructional. The erosion phenomena are the wave-cut cliffs. The glacial lakes were commonly too ephemeral or too unsteady in their levels to produce conspicuous erosion features. However, the larger and longer-lived lakes, as Newberry, Warren, Dana and specially Iroquois, have left many cliffs.

Constructional Work.—Beach Ridges, embankments of sand and gravel, the bars and spits of wave and shore current construction, are the complement of the erosion work but are much more common and are frequently very prominent features. They have long been recognized by the people as the work of mysterious waters at high altitudes. For long stretches the beach ridges have been utilized for "ridge roads," while the level stretches of wave-base along the beaches have afforded graded paths for railroads and canals. The strongest ridges are those of Whittlesey and Warren in the Erie basin, and of Iroquois in the Ontario basin.

Deltas: Of the several shore phenomena deltas are the most useful in proving the former presence and determining the altitudes of the extinct lakes. The production and size of the delta deposits are not wholly conditioned by the size of the receiving water body, but by the volume of the stream detritus relative to the distributing work of the receiving waters. Hence deltas may be built in small lakes, and these hung-up mounds and terraces of gravel on the valley sides serve well to mark the shores of lakes that were too ephemeral or too small to produce either cliffs or bars. Naturally the deltas occur in the courses of land streams, and a vertical succession of bisected delta terraces commonly indicate the falling levels of the lake. Fine examples of these gravel terraces are found on the slopes of the Finger lakes valleys and some of them are conspicuous features, like the terraces by Coy glen, visible from the Cornell University campus.

Delta Plains: Genetically related to deltas are the plains of gravel, sand or clay which may be extended in area and indefinite in limits. Such plains usually represent wave-base, perhaps twenty feet or less beneath the water surface. When partially eroded the remnants present extended horizontal lines, excellent examples of which may be seen throughout the Mohawk Valley and about the Irondequoit Valley east of Rochester, clearly visible from the trains on the New York Central Railroad. Some of the larger valleys declining toward Lake Erie exhibit broad terraces at various levels. A fine display may be seen from the Pennsylvania Railroad from East Aurora up to Machias. Evidently such lake plains can occur only north of the divide. Some plains similar in appearance in the valleys south of the divide fall into the categories of outwash plains or of river flood plains.

Scores of examples of detrital plains built in glacial waters by the land drainage might be cited. In the Erie basin the great plain in the Cattaraugus Valley below Gowanda and that built by Silver and

Walnut creeks between Forestville and Silver Creek villages may be mentioned. A very fine illustration is found on the Rochester sheet. The area between the Genesee River and Irondequoit Bay and between Lake Ontario and Iroquois beach ("Ridge Road") is the submerged delta plain of the Genesee River in Lake Iroquois, now much dissected by present-day streams. The flat stretches about Irondequoit Bay bounded by the 400-feet contour are remnants of the silt plain which in Iroquois time filled the whole breadth of the valley.

Sandplains built by the ice-border glacial drainage are also numerous. These include, for example, the plains on the west side of the Genesee Valley opposite Avon; the eroded area north and northwest of Geneva; the mesa-like plains in the Onondaga Valley at South Onondaga and northwest by Cedarvale; and the plain on which stands the business part of Syracuse.

The very extensive and conspicuous sand plains and terraces on both sides of the Champlain and Hudson valleys, including the great delta plain between Schenectady and Albany contributed by the Iromohawk River, were built in sea-level waters that occupied this depression during the time of the ice removal.

Clay Plains: Where the static waters were wide and deep so as to permit full assorting of the detritus, more or less clay was spread over the bottom in the more quiet water. The best example is found in the Iroquois Lake basin. In the St. Lawrence Valley east of Cape Vincent, Alexandria Bay and Ogdensburg are extensive stretches of finely laminated and deep clays, the glacial origin of which is indicated by the abundance of lime concretions. The heavy clay deposits of the Hudson Valley belong in this class, but were deposited in sea-level waters.

Morainal Lakes.—This class includes the hundreds of lakes and lakelets (so-called ponds) now in existence that are scattered over the state and most numerous in the Adirondacks. They owe their existence to the blockade of valleys or drainage courses by glacial drift. The term drift-barrier lakes would be the more accurate name. Great numbers of such lakes have already been obliterated, mostly changed into swamps by marl and peat accumulation or by detrital filling: and all these lakes are doomed to similar ultimate extinction either by filling or draining.

The Finger lakes probably owe their origin in part, at least in their upper levels, to drift barriers.

Cataract Lakes.—The most singular and interesting lakes in the state lie in the courses of ancient ice-border rivers. These occupy the plunge basins of extinct cataracts. Niagara to-day illustrates the method in production of a basin or bowl by the excavating work of a large cataract. If Niagara River were to be diverted above the fall so as to extinguish the cataract a rock basin holding a lake would be left in the amphitheater beneath what is now the "Horseshoe" falls. South and east of Syracuse the predecessors of Niagara River plunged over cliffs of the Onondaga limestone in their eastward flow and produced several plunge basins with lakes, two of which outrival Niagara.

The Jamesville Lake, four miles southeast of Syracuse, is a circle of emerald-green water about one eighth mile in diameter, and 60 feet deep, lying in a half-circle amphitheater with perpendicular rock walls 160 feet high. Two and one half miles east of Jamesville Lake, across the Butternut Valley, is Blue Lake, resting in a cataract basin and rock amphitheater equaling the Jamesville in dimensions but not so symmetrical. White Lake, one half

mile north of Blue Lake and Round and Green lakes nine miles east of Syracuse, have basins with low and sloping walls because the rocks are the soft Salina shales.

These lakes were formerly regarded as mysterious and with their enclosing amphitheaters were the cause of much speculation. Their nature was first announced by G. K. Gilbert and the first geologic description in recognition of their true character was by Quereau.[10]

These cataract lakes are very remarkable features, and representing as they do an ancient drainage of the Great Lakes area, held at high levels by the glacier front, they have a scientific and educational value not yet appreciated.

Lakes of Complex Origin.—This title is intended to include Lake Ontario and the larger Finger lakes, as Cayuga and Seneca, the genesis of which is not entirely clear. The bottoms of these lakes are below sea-level, and we do not know what depth of drift lies yet deeper beneath the water. At Watkins a well boring penetrated 1,200 feet without reaching rock, which shows drift at a depth 600 feet lower than the deepest part of the lake, and 750 feet beneath sea-level.

It seems probable that the valleys of the Finger lakes are blocked on the north, along the drumlin belt, by deep drift fillings, which can be determined only by borings at close intervals. That these valleys were gouged out by ice erosion, even by any number of continental ice sheets, seems to the writer extremely improbable. If they were so deepened, then the basin of Lake Ontario was probably also scooped by ice erosion. But if the Ontario basin is a depressed river valley, then the valleys of the Finger lakes must be fairly graded to the bottom of Ontario and be of similar origin. If the Ontario and other basins were excavated by river work and weathering, then it must be admitted that there have been great changes in the height and attitude of the land in late geologic time. But such changes are quite certain. It appears probable that the valley-cutting occurred during a time of land elevation, and that the Laurentian and the Finger lakes basins are the complex product of land warping, land depression, and of glacial drift filling. Until the later Tertiary and Pleistocene diastrophic movements of the area including New York have been determined and the drift-buried valleys mapped by borings the deep lake basins may remain the subject of speculation and dispute.

[10] "Topography and History of Jamesville Lake," by E. C. Quereau, Geol. Soc. Am., *Bull.*, Vol. 9, pp. 173–182, 1898. See also illustrated article by Fairchild in the 20th Ann. Rep., N. Y. State Geologist, 1900, pp. 126–129.

GLACIAL LAKE SUCCESSION

The story of the succession of the glacial waters that laved the receding front of the Laurentian glacier is a dramatic episode in the geologic history. Beginning in small pondlings of water in the heads of the valleys along the north side of the morainic divide, the lakes were enlarged as the ice barrier receded, and were captured, drained, blended or otherwise affected by changes in outlets. The romantic story can not be satisfactorily told in words alone, but requires cartographic representation, and a series of maps has been constructed to show the better known and more striking changes in the ice recession and the lake succession.

The control of the glacial waters depended on the altitude of the lowest passes affording immediate outflow along with the relation of these passes to some ultimate escape. The waters of the Laurentian basin outflow to-day by the St. Lawrence

(246 feet). With that escape blocked the lowest pass is at Rome (460 for the water surface) to the Mohawk-Hudson, and which for many thousands of years was the point of escape of the waters while the ice body lay over the St. Lawrence Valley. The next higher pass is at Chicago, which was occupied by the glacial outflow for a very long time, but to reach this ultimate escape the Ontario-Erie-Huron waters were compelled to cross Michigan by the valley of Grand River.

The lowest pass leading southward in New York is at Horseheads, the head of the Seneca Valley, leading to the Chemung-Susquehanna with altitude of 900 feet. These three outlets, Horseheads, Grand Valley, Michigan and Rome were the channels of ultimate escape for the waters of western and central New York until the ice was removed from over Covey Gulf, north of the Adirondacks. In immediate control of the waters of central New York, the Seneca-Cayuga depression and the Genesee basin, there were two localities, the salient or highland on the Batavia meridian and the highland in the Syracuse district. The earliest glacial waters in New York were held in the Genesee Valley, and this continued for a long time as a distinct basin with several successive outlets.

When we consider the glacial lakes and drainage in chronologic order we find that the earlier waters were confined in two separate basins, the Genesee and the Seneca-Cayuga. That for a brief time the Horseheads outlet (Lake Newberry) probably occupied the Genesee Valley, and then for a long time the control was alternately west on the Batavia meridian or east in the Syracuse district. Then, when the ice front weakened on the Batavia salient the westward control was across Michigan (Lake Warren level). All the later flow, subsequent to Lake Warren, was eastward to the Hudson until the northward flow through Covey Gulf and the Champlain Valley to the Hudson.

The most extended series of glacial lakes was in the Genesee Valley. This long valley, the surviving example of the Pre-pleistocene northward drainage, heads in Pennsylvania, at the terminal moraine, with altitude on the cols over 2,200 feet, and extends across the state to near Rochester, where it blends into the Ontario lowland at about 600 feet altitude. The fall of 1,600 feet in a right-line distance of 80 miles gave opportunity for many successively lower outlets and water planes as the ice released passes on the east or west borders of the basin. Probably the glacial lake history of the Genesee Valley is more complicated than is now known, but no less than eighteen distinct outlets with correlating lake levels have been recognized. Then the drainage was directly into the sea (Gilbert Gulf), and finally into Lake Ontario. In this varied outflow the Genesee glacial waters were contributed to several far-separated river systems. Named in order of time these are: (1) Pine creek-Susquehanna; (2) Alleghany-Ohio-Mississippi; (3) Canisteo-Chemung-Susquehanna; (4) Erie basin (Lakes Whittlesey or Warren)-Michigan basin (Lake Chicago)-Mississippi; (5) Seneca Valley (Lake Newberry)-Susquehanna; (6) Mohawk-Hudson; (7) Champlain-Hudson; (8) Ocean-level waters direct; (9) Lake Ontario-St. Lawrence. Some of these systems received the Genesee Valley overflow more than once, or by different immediate outflow, making the twenty stages in the drainage history as now understood. It would seem unlikely that any other valley in the world can approach the Genesee in the complexity of its drainage history.

The series of seventeen maps depict the waning Laurentian ice sheet with the gla-

cial and marine waters that lay against its receding border. The local lakes in the side valleys of the Hudson depression and about the Adirondack highland are not indicated; and the ice border is more or less generalized. The latter is located definitely along the lines of the ice-border drainage.

lowed up the Hudson Valley, finally reaching the Champlain basin and eventually uniting with the oceanic waters of the St. Lawrence Gulf. The Hudson inlet thus became the Hudson-Champlain inlet and finally the Hudson-Champlain strait, connecting New York Bay with the Champlain Sea. When the ice front backed away

GLACIAL LAKES OF NEW YORK STATE

Drainage Provinces						
Erie	Genesee	Seneca	Mohawk	Black	St. Lawrence	Hudson-Champlain
	1. Three Primary					
	2. Pennsylvania					
Ice	3. Wellsville	*Ice*				
	4. Belfast-Fillmore		*Ice*			
	5. Portage-Nunda	Several Primary		*Ice*		*Hudson inlet* (*marine*)
	6. Dansville					
Whittlesey	7. Mt. Morris-Genesee	Newberry				
	8. Newberry		Herkimer			
	9. Hall	Hall	Schoharie		*Ice*	
	10. Vanuxem	Vanuxem	Amsterdam			
Warren	11. Avon	Montezuma		Forestport		
	12. Second Vanuxem	Second Vanuxem	*Glacio-Mohawk river*	Port Leyden		*Hudson-Champlain inlet*
	13. Warren	Warren		Glenfield		
Dana	14. Dana	Dana				
	15. (?)					
	16. Dawson	Iroquois	*Iromohawk river*			
	17. Iroquois			Iroquois	Iroquois	
Erie	18. Second Iroquois.	Second Iroquois			Second Iroquois	
	19. *Gilbert Gulf* (*marine*)	*Gilbert Gulf* (*marine*)	*Mohawk river*	*Black river*	*Gilbert Gulf*	*Hudson-Champlain strait*
	20. *Ontario*	*Ontario*			*St. Lawrence river*	

The accompanying chart shows the time relationship of the waters in the several basins of the state. The vertical spacing is only suggestive of the succession of the waters and their geographic relations, and has little significance as to the duration of the episodes.

MARINE WATERS

During the waning of the latest ice sheet the Hudson-Champlain Valley and the St. Lawrence and Ontario basins were beneath the level of the ocean. As the ice front receded northward the sea-level waters followed

from the Covey Hill promontory the glacial waters of the Ontario basin, the Second Iroquois, fell to and became confluent with the sea-level waters. The highest plane of the sea-level waters in the Ontario basin is relatively weak and has not been fully determined, but an inferior level of long persistence showing heavy bar construction has been mapped and named Gilbert Gulf. This stage, which includes the series of strong bars at Covey Hill post-office, is depicted in map number 16.

On the parallel of New York City it ap-

pears that the land at the time of the ice recession was at, or perhaps somewhat above, sea-level. Northward the land was increasingly below sea-level. The upraised and tilted water plane which indicates the amount of Pleistocene submergence or of Postpleistocene uplift rises steadily from zero or present sea-level in the district of New York City to over 750 feet on the Canadian boundary.

The supposed absence of marine fossils in the Hudson Valley is doubtless due to the freshening of the waters by the copious glacial and land drainage. Until the episode of the Second Iroquois the flood of glacial waters of the St. Lawrence basin was poured into the Hudson inlet at Schenectady. During the Second Iroquois the glacial flood was merely shifted to the north, and during all the long life of the Hudson-Champlain inlet all the fresh waters were forced south. However, marine fossils are abundant in the Champlain Valley and are found at altitudes the planes of which carry over the Fort Edward divide into the Hudson portion of the great valley.

The detrital deposits formed in the marine waters are large in volume and area. Up the Hudson as far as Catskill the terraces of clay and sand are very conspicuous and afford the materials for brick manufacture on an immense scale. North of Catskill, in the widening valley, the summit sandplains lie back from the river, though lower terraces may yet be seen. While much of the deeper deposits and those in the middle of the valley or beneath the present waters are of glacial origin, the heavy visible deposits are chiefly the deltas of tributary land streams, the greatest, being that of the Iromohawk at Schenectady-Albany.

From Troy to Glens Falls the borders of the lower valley are buried in a deluge of sand, sloping down in terraces toward the axis of the valley. Saratoga lies in the midst of a vast area of detrital marine accumulations. The slow lifting of the valley out of the waters gave the latter an excellent chance to produce level stretches and conspicuous terraces, the latter being more prominent as the steeper slopes approach the middle of the valley. The Champlain portion of the great valley also holds vast sandplains, especially on the larger rivers, as the Ausable, Saranac and Big Chazy.

EPEIROGENIC MOVEMENT. DIASTROPHISM

The great changes in altitude of the surface of the state, both before and since the glacial occupation, has already been noted. The relation of the land movement to the burden of the ice cap should be briefly discussed. If the earth's crust is sensitive to long-continued pressures, then the thickness and weight of the ice body becomes an important matter.

Again our lack of knowledge of the duration and diastrophic effects of the Prewisconsin ice caps limits our discussion to the effects of the Laurentian ice body.

At its maximum the thickness of the ice cap over the Adirondacks and the Champlain Valley was probably not less than 10,000 feet. This is equal in weight to over 3,000 feet of rock. Southward the ice decreased in thickness and weight to zero in the region of New York Bay. The amount of postglacial uplift increases from zero in the district of New York Bay to over 750 feet on the north boundary of the state. The correspondence between the thickness of the ice cap and the amount of postglacial uplift of the land is very striking and significant. All about the Laurentian basin the tilted shores of the extinct glacial lakes afford us evidence of the differential uplift of the glaciated territory.

The average northward uplift or tilt of the marine plane in the Hudson and Champlain Valley appears to be about two and one fourth feet per mile, but some higher and as yet uncorrelated shore features in the Champlain Valley suggest a deeper submergence there and a larger rate of uplift. It seems quite certain that the increase of the gradient northward that is apparent west of the Adirondacks must also occur on the east of that mountain mass. The differential uplift between the Iroquois plane at Rome (460 feet) and at Covey Gulf, on the Canadian boundary (1,025? feet), is about 565 in a distance of 149 miles in a direction 33° east of north, giving a slant of 3.8 feet per mile. The grade from Richland to East Watertown is toward 6 feet per mile.

In east and west direction there is small deformation. The Iroquois plane at Hamilton, Ont., is given as 363 feet. At Rome it is 460 feet, which makes an eastward uplift of 100 feet in 225 miles, 0.4 foot per mile.

The steadiness or uniformity of the tilted marine plane in the Hudson and southern part of the Champlain valleys is somewhat surprising. It does not seem probable that all land uplifting was deferred until the ice was removed from a stretch of 200 miles and that the rise and tilting was that of a rigid mass. It would seem more likely that as the weight of the ice sheet was slowly removed it was followed by a progressive wave of land uplift. However, the final result of an epeirogenic wave-like uplift might be a fairly uniform plane, simulating that produced by tilting of a rigid surface.

POSTGLACIAL EROSION

Land erosion since the ice sheet disappeared is exhibited in wave cutting by the lakes and canyon cutting by diverted streams. In postglacial ravines New York state excels. We may recall Niagara, the three ravines in the course of the Genesee, the Ausable chasm, Watkins glen. But there are great numbers of glens or steep-walled rock gorges throughout the state which are quite as interesting and instructive as these, even if smaller and unadvertised.

When applied to the effects of erosion in New York the term "postglacial" needs explanation, for much canyon cutting was effected while the ice sheet still lingered on territory of the state. For example, the Portage ravine of the Genesee began cutting while the ice front was not far away on the north. The Mount Morris ravine, the "High Banks," was in the making while the ice covered Rochester. And the upper (south) section of the Rochester canyon was largely cut while Lake Iroquois waters prevented the excavation of the lower part of the gorge. Certainly a large part of the erosional work in central and western New York and the Hudson Valley occurred while the glacier still covered the northern lowlands of the state, including the Champlain Valley.

GLACIAL TIME

The first question commonly asked by the non-geologist is, "how long ago?" We have to admit ignorance of any precise measure of geologic time. Geologists have learned to think in millions of years, and they are not greatly concerned with the precise duration of so short a period as the glacial or postglacial episode. However, precise knowledge is desirable and a yard-stick of geologic time must be sought. All attempts to use the present rate of canyon cutting or cataract recession as an index of time have failed, and no data yet discovered have much value.

The history of the ice-front recession with its long succession of lakes and well-

developed river channels compels the extension of our estimates of the length of glacial time, and all studies on glacial geology have the same result.

If we take 10,000 years as a moderate estimate of the life of Lake Ontario, then we must add an equal, and perhaps much greater, time for the lifting of the basin out of the marine waters. Then we must allow at least another 10,000 years for the duration of Lake Iroquois; and the 30,000 years carries us back only to the time when the ice sheet was removed from the western part of the state. This appears to be but a minor portion of the time covered by the waning of the glacier, judging from the maps and the known history preceding the initiation of Lake Iroquois.

If we assume 75,000 years as the time in the waning of the ice sheet, then we seem compelled to add an equal time for the invasion of the ice, with some time in addition for the pause at the terminal moraine. Most glacialists will probably agree that 150,000 years for the length of the latest or Wisconsin ice epoch is a fair estimate. And back of this we have the earlier and much longer glacial and interglacial epochs. The estimates of those best qualified to judge of the length of Pleistocene time are from 500,000 to 1,500,000 years.

WORK OF THE STATE SURVEY

The Pleistocene phenomena of the state have been the subject of casual observation and publication for over half a century, and a bibliography would be too large to present here. But the glacial and Pleistocene is the youngest member of the geologic branches of study, and only in recent years has the New York State Museum financed the glacial study as a distinct line of field-work and publication. This assistance, however, has been generous and effective, as the numerous papers and handsome maps published since 1900, and especially since 1905, will bear witness. The only elaborate and expensive maps and text published under other auspices than the State Museum is the U. S. Geological Survey Folio 169, already cited above. A description of the Moravia quadrangle by Carney was published in 1909 by Denison University, with a sketch map in black and white.

The more important Pleistocene publications of the State Museum are Bulletins 48, 83, 84 by Woodworth; 154 by Stoller, and 106, 111, 127, 145 (in part) and 160 by Fairchild. Earlier papers by the writer are contained in the 20th Annual Report of the State Geologist, 1902, 21st Report, 1903, and the 22d Report, 1904. Previous papers by the writer on the Pleistocene features of the state were published in the *Bulletin* of this society, beginning in 1895, and in other scientific journals.

For effective future work it is desirable that some scheme or far-sighted plan should bring all the glacial studies of the state into harmonious cooperation for the large result. And also that a cartographic scheme should be adopted that will secure maps as uniform in convention and color as possible.

Two important subjects requiring systematic study are the moraines and the drift-buried valleys. The state should undertake the mapping of the buried valleys. It should employ a well-boring outfit to secure data for accurate profiles of the hard-rock surfaces beneath the drift north of the Finger lakes, and wherever the Preglacial valleys of scientific interest are obscured. This would be a unique and popular work for the State Museum. The expense of such exploration would not be large, while the scientific and educational value would be great.

Another duty of the state is the preservation intact of the Jamesville and Blue lakes

cataract features. These splendid evidences of an ancient glacial drainage, antedating Niagara and corresponding in function, should be made state property and preserved for the people. They are scenic features of as much beauty and of much more educational value than Watkins Glen and some other state parks.

HERMAN L. FAIRCHILD

UNIVERSITY OF ROCHESTER

THE DIVISION OF EDUCATIONAL INQUIRY UNDER THE CARNEGIE FOUNDATION

MR. ANDREW CARNEGIE has given $1,250,000 to the Carnegie Foundation for the Advancement of Teaching. The gift was announced on the eleventh, at a meeting of the executive committee at its offices, 576 Fifth Avenue. The gift is in the form of 4 per cent. bonds and the income is to be set aside for special investigation relative to the purposes of the original foundation of pensioning college professors.

The announcement of the executive committee states that the money is to be devoted to the endowment of a Division of Educational Enquiry and makes permanent provision for studies hitherto conducted by the foundation out of its general fund. It is the plan of the trustees to proceed with the new endowment to make other studies similar to those already published concerning medical education and in particular to study legal education in its relation to the supply of lawyers and the cost of legal process.

Mr. Carnegie's letter to the trustees is as follows:

CARNEGIE CORPORATION OF NEW YORK,
January 31, 1913.

TO THE TRUSTEES OF THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING.

Gentlemen:—Appreciating the valuable results of the educational studies of the Foundation and being of opinion that it is desirable that a fund be established to secure such results and conduct such investigations as may aid you in your work and realizing that sufficient income may not now be available for that purpose, I hereby offer to the foundation the sum of one million and a quarter dollars four (4) per cent. bonds, to be held and used by the foundation upon the following terms:

I. There shall be organized in the foundation an agency for the study of education and educational institutions, to be designated the Division of Educational Enquiry.

II. Any endowment or funds conveyed to the foundation for the use of such division shall constitute and be held as a special fund and the income alone be used and shall be accounted for separately from the general funds of the foundation and shall be devoted to the purposes hereinafter named.

III. It shall be the function of the Division of Educational Enquiry to conduct studies and to make investigations concerning universities, colleges, professional schools, and systems of education generally, to investigate problems of education affecting the improvement of educational methods, the advancement of teaching, or betterment of educational standards, and in general to investigate and to report upon those educational agencies which undertake to deal with the intellectual, social and moral progress of mankind and to publish such results as the trustees may consider of value.

IV. The income of the Division of Educational Enquiry shall be used in the expenses incident to the performance of the work of the Division of Educational Enquiry as hereinbefore set forth, as may from time to time be undertaken and published by the foundation, but no part of the income of the fund or funds specifically given for the use of this division shall be used in the payment of pensions.

It is my purpose to aid the trustees of the foundation to conduct their work upon broad lines and to enable them to obtain such information as will make the whole endowment of the Foundation of the greatest possible service to mankind.

Yours truly,
(Signed) ANDREW CARNEGIE,
President.

THE MILWAUKEE MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE forty-seventh annual meeting of the American Chemical Society will be held in Milwaukee, Wisconsin, March 25 to 28, inclusive. A meeting of the council will be held on March 24, at the Hotel Pfister, which is the hotel headquarters. The meetings will be held at Marquette University, Grand Ave. and 11th

St., where every facility is offered for the meetings of the divisions in the center of Milwaukee's business section.

Mr. C. H. Hall is chairman of the local committee and Mr. P. J. Weber, secretary. The finance committee is under the chairmanship of Mr. G. N. Prentiss. Reception, registration and information committees are under the chairmanship of Mr. E. V. Manuel. The committee on arrangement has Mr. H. W. Rohde as its chairman, Mr. F. E. Layman is chairman of the entertainment committee, and Mr. C. R. McKee is chairman of the committee on entertainment of ladies.

The entertainment committee is planning an interesting program, which will be an undoubted success, and special attention is being paid to preparations for the entertainment of ladies at such times as they can not participate in the regular program. Many manufacturing plants will be visited, and although no definite arrangements can be announced in the present circular, it may be stated that Milwaukee contains important works covering the tanning industry, manufacture of iron and steel, by-product coke and gas, manufacture of glue, manufacture of automobiles and automobile parts, automobile tires, packing industry, manufacture of refrigerating machinery, gasoline engines, kerosene engines, and shops of railroad companies, most of which will be open to the members.

All the divisions will meet. It is probable that the Biological Division will be duly organized at this meeting. Members are especially asked to note the excursion to Madison, Wisconsin, on Friday, March 28. The Society has a special invitation from President Van Hise, of the University of Wisconsin, and it is hoped that all those who attend the meeting will also go to Madison. The city is but seventy miles from Milwaukee and is of special interest, being the seat of the state capitol, the University of Wisconsin, the United States Forest Products Laboratory, and the location of a large beet-sugar refining plant, which, if present information is correct, will be in operation at the time of the convention.

All papers for the meeting must be in the secretary's hands on or before March 7 or in the hands of secretaries of divisions by March 5, in order to be on the program. By vote of the council no papers can be presented at the meeting that are not printed on the final program.

The following are the addresses of the divisional and sectional secretaries:

Industrial Division—M. C. Whitaker (*pro tem.*), Columbia University, New York City.

Physical and Inorganic—R. C. Wells, U. S. Geological Survey, Washington, D. C.

Fertilizer—J. E. Breckenridge, Carteret, N. J.

Agricultural and Food—G. F. Mason, care of Heinz Company, Pittsburgh, Pa.

Organic—Wm. J. Hale, University of Michigan, Ann Arbor, Mich.

Pharmaceutical—Frank R. Eldred, 3325 Kenwood Ave., Indianapolis, Ind.

Rubber—Dorris Whipple, care of The Safety Insulated Wire and Cable Company, Bayonne, N. J.

Biological—I. K. Phelps, Bureau of Mines, 40th and Butler Sts., Pittsburgh, Pa.

Chemical Education—J. F. Norris, Simmons College, Boston, Mass.

SCIENTIFIC NOTES AND NEWS

Sir David Gill has been elected the first honorary member of the Astronomical and Astrophysical Society of America.

Sir William Tilden, F.R.S., the British chemist, has been elected a corresponding member of the Imperial Academy of Sciences, St. Petersburg.

The gold medal of the Royal Astronomical Society has been awarded to M. Henri Alexandre Deslandres for his investigations of solar phenomena and other spectroscopic work.

The Langley medals of the Smithsonian Institution are to be conferred on M. Gustav Eiffel, the French engineer, and Mr. Glenn H. Curtiss, known for his development of the hydro-aeroplane.

Mr. F. W. Hodge, of the Bureau of American Ethnology, Smithsonian Institution, has been elected a corresponding member of the Société des Américanistes de Paris.

Professor Poulton, F. R. S., Professor Bourne, F.R.S., and Mr. E. S. Goodrich,

F.R.S., have been appointed to represent Oxford University at the International Congress of Zoology, to be held this year at Monaco.

Professor A. Keith has been elected president of the Royal Anthropological Institute of Great Britain and Ireland.

Dr. E. B. Rosa, of the Bureau of Standards, gave the address of the retiring president before the Philosophical Society of Washington on February 15. His subject was "The Function of Research and the Regulation of National Monopolies."

Professor Charles Lapworth has expressed the desire to vacate the chair of geology in Birmingham University at the end of the current session.

The Chemist and Druggist, London, reports the appointment, by the Pharmaceutical Chemistry Section of the Eighth International Congress of Applied Chemistry, of an international commission to continue the inquiry on "Variation in the activity of certain toxic drugs" and to report at St. Petersburg in 1915. The commission named is as follows: Austria, Professor Wilhelm Mitlacher; France, Professor E. Bourquelot; Germany, Professor H. Thoms; Great Britain, Francis Ransom, F.C.S.; Netherlands, Professor L. van Itallie; Switzerland, Professor A. Tscheich; United States, Dr. Rodney H. True. Three secretaries for the commission were also appointed: European Continent, George P. Forrester, F.C.S.; Great Britain, Peter MacEnau, F.C.S.; United States, Otto Raubenheimer.

Professor H. Louis Jackson, B.S. (Mass. Inst., '05), who has held the position as assistant professor of chemistry in charge of foods at the University of Kansas since 1907, has accepted the position of state chemist of Idaho. He will go at once to Boise, where the laboratory is located.

Franz Schneider, Jr., '09, instructor at the Massachusetts Institute of Technology, has accepted the position of sanitary expert to the department of surveys and exhibits, Russel Sage Foundation. For the lecture work that has been carried on by Mr. Schneider, W. C. Purdy, professor of biology at Geneva College, has been called and will be named assistant in biology.

The Peruvian government has officially designated Mr. Charles H. T. Townsend director of entomological stations in addition to his title of government entomologist, extending his contract to December 31, 1913. A central station of agricultural entomology is already established in temporary quarters at Lima, for the general investigation of insect plagues of agriculture in the central coast region. It is intended to maintain the branch station of agricultural entomology in the department of Piura, for continuing the investigation of cotton insects and their enemies. A station of medical entomology has been established at Chosica, where an investigation of the blood-sucking arthropods of the verruga zones has already been started to determine what species may be the carrier of verruga fever. Mr. E. W. Rust has been transferred from Piura to Lima, and Mr. J. G. Cateriano has been added to the force. Several graduates from the School of Agriculture will be trained in agricultural entomology, and a graduate or two from the School of Medicine will be trained in medical entomology at Chosica.

The Museum of Zoology, University of Michigan, will send a second expedition to Whitefish Point, Chippewa County, Michigan, in the summer of 1913, to continue the work started in that region in 1912. The 1913 work, like that of 1912, will be supported by Hon. George Shiras, and the results will be published under the same general title "Results of the Shiras Expeditions to the Whitefish Point Region, Michigan."

Professor C. E. McClung, of the University of Pennsylvania, lectured before the Society of the Sigma Xi of that university on February 7, his subject being "Sex Determination."

The first lecture of the year before the Ohio State University Chapter of Sigma Xi Society was given by Dr. A. W. Gilbert, Cornell University, on the topic "The Method and Scope of Genetics." The officers of the Ohio State

University Chapter of the Sigma Xi Society this year are Dean David S. White of the College of Veterinary Medicine, president; J. S. Hine, associate professor of biology, vice-president; F. C. Blake, professor of physics, treasurer, and James R. Withrow, professor of industrial chemistry, secretary.

PROFESSOR A. M. TOZZER, of Harvard University, during the mid-year period, gave lectures before the various societies of the Archeological Institute of America in the following places: St. John, Halifax, Quebec, Montreal, Ottawa, Toronto, Hamilton, Buffalo, Rochester, Auburn and Syracuse.

ON February 7, Professor Edward L. Thorndike, of Teachers College, Columbia University, delivered in the afternoon a lecture on "Social Instincts" before the department of psychology of the John Hopkins University; and, in the evening he addressed the Educational Society of Baltimore on "Retardation and Elimination in High School."

PROFESSOR J. S. PRAY, chairman of the department of landscape gardening of Harvard University, gave recently two lectures at the University of Illinois on the subjects "Functional City Planning" and "Gardens Old and New."

MONSIEUR J. M. F. DE PULLIGNY, ingenieur en chef des ponts et chaussées, et directeur, Mission Francaise d'Ingenieurs aux Etats-Unis, New York City, on February 11, delivered an illustrated lecture on "The Public Service of Roads in France," before the graduate students in highway engineering at Columbia University.

ON February 4 Professor G. H. Parker lectured before the Vassar Brothers' Institute, Poughkeepsie, N. Y., on "The Evolution of the Nervous System."

THE Alumni Association of the Michigan College of Mines has published its January number of *The M. C. M. Alumnus*, which is a memorial to Professor George A. Koenig, head of the department of chemistry, who died in Philadelphia on January 14. The number contains a full-page engraving from a late photograph, a biography and the addresses of the memorial service.

PROFESSOR JULIUS FRANZ, director of the astronomical observatory at Breslau, has died at the age of sixty-five years.

DR. G. DE LAVAL, the well-known Swedish engineer and inventor, has died at the age of sixty-seven years.

THE Civil Service Commission invites attention to the regular spring examinations for scientific assistant, Department of Agriculture, to be held April 9 and 10. The entrance salaries are from $1,000 to $1,800. Examinations will be given in the following subjects: agronomy, dairying, entomology, farm economics, farm equipment, forage crops, general farm management, horticulture, library science, nutrition and calorimetry, plant breeding, plant pathology, pomology, seed testing, soil bacteriology, soil chemistry, soil surveying. An examination will be held on March 10 for senior highway engineer, to fill vacancies as they may occur in this position in the office of public roads, Department of Agriculture, at salaries ranging from $2,000 to $2,400 a year.

UNIVERSITY AND EDUCATIONAL NEWS

THE sum of $75,000 has been subscribed and given to Vassar College to endow a chair of physical science.

IN a recent issue of SCIENCE, mention was made of the bequests of Levi N. Stewart, of Minneapolis, to Dartmouth, Bowdoin and Bates Colleges. In addition Mr. Stewart bequeathed $75,000 to Colby College.

MR. DAN R. HANNA, proprietor of the Cleveland *Leader and News*, has offered to the Western Reserve University ten thousand dollars a year for establishing a School of Journalism. The school will be coordinated with the other professional schools of the university, and will be its ninth department. Adelbert College, the college of arts and sciences for men, is the oldest department. It was founded as Western

Reserve College in 1826, and refounded as Adelbert College of Western Reserve University in 1882. The School of Medicine was founded in 1843, the School of Pharmacy in 1882 and the College for Women in 1888. In 1892, the School of Law, the Graduate School and the Dental School were founded. The Library School was founded in 1904.

THE actual number of law schools in the United States only increased from 102 to 118 in the decade from 1902 to 1912, according to figures compiled at the U. S. Bureau of Education, but the number of students studying law in these schools increased from 13,912 to 20,760 in same period. There were 3,524 graduates of law schools in 1902 and 4,394 last year. Law students, having a collegiate degree, doubled in the ten years. Financially the law schools show a remarkable advance. The endowment funds increased from half a million to nearly two million dollars; the grounds and buildings tripled in value; and the total income in 1912 was $1,368,000, as against $523,-000 in 1902. The 387,000 volumes in the law-school libraries of 1902 had grown to 936,000 in 1912.

DR. FREDERIC LYMAN WELLS, assistant in pathological psychology at the McLean Hospital, is conducting a course of lectures and discussions on "Pathological Psychology" at Harvard University.

DR. FREDERICK G. DONNAN, F.R.S., has been appointed to the chair of general chemistry at University College, London, recently vacated by Sir William Ramsay, F.R.S.

DR. WILLIAM J. DAKIN, F.R.S., at present assistant professor at London University, has been appointed professor of biology at the University of Western Australia, Perth. Dr. Alexander D. Ross, of Scotland, has been appointed professor of mathematics and physics in the same institution.

DISCUSSION AND CORRESPONDENCE

A PLAN FOR THE ENCOURAGEMENT OF MEDICAL RESEARCH

JUDGING by the number of bequests and endowments directed toward that end, the furthering of medical research is an attractive field for philanthropic endeavor if not for public investment. As one of the rank and file who are working toward the advancement of medical science I would suggest that no method of encouraging such research has heretofore been wholly successful. The foundation of institutes for this purpose is effective in case of the favored few who happen to be reached, but for most scientists (including the clinical variety), who are engaged in teaching in medical schools, who constitute the great proportion of the working force, such foundations are of little assistance.

The most effective plan would seem to be that by which actual accomplishment is rewarded without unduly favoring any one. Such a result could be achieved by the simple expedient of endowing the periodicals devoted to the publication of research so that contributed articles could be paid for according to their merit. Such an arrangement would obviate the most discouraging feature of working in many institutions, the feeling that unusual effort is, from a selfish point of view, not merely futile but even detrimental, in that leisure for reading, recreation and family life is sacrificed without compensating gain.

The plan in operation would be simplicity itself. Rewards would go automatically to those who earned them. The chief difficulty seemingly would be to secure editorial boards fair minded enough to decide justly upon the merits of each contribution, but that difficulty would be by no means insurmountable. In any case to assign a value to a given piece of research would be much easier than to forecast which of a dozen men would be accomplishing the most effective work ten years later, a forecast which, as a matter of fact, has to be made in each instance, before a desirable research or teaching position can justly be assigned.

It is recognized that the best endeavor can not be bought, and that the best rewards of a scientific career are not pecuniary—"but that is another story!" Whatever merit there is in financial encouragement would seem best

to be secured by some such as the foregoing plan.

R. G. Hoskins

Starling Ohio Medical College

GRANA DE BRASILE

To the Editor of Science: I should be glad to learn what grain and what region were meant by "grana de Brasile" in the 1193 commercial treaty between the "Bononienses" and "Ferrarienses" copied by Muratori into Vol. 2 of his "Antiquitates Italicæ," p. 844. He mentions (p. 488) the repetition of the same item in a "charta" of 1198.

Capmany's Spanish work on the early shipping arts, etc., of Barcelona copies in Vol. 2 several thirteenth century Catalan tariff lists, three of which (the earliest 1221) for that and other parts, respectively mention, among miscellaneous commodities, "Carrega de Brasill," "faix de bresil" and "cargua de brazil." The usual impost seems to have been two solidos. One of these lists mentions "grana" unqualified. There seems nothing to indicate what material was or was not meant, except the slight negative value of that reference.

It is interesting to see the variations of orthography in these lists, duplicating those of the Brazil west of southern Ireland on the fourteenth and fifteenth century maps, though Fra Mauro adds berzil and the more southern apparently imitative Brazils (Terciera and others) exhibit further vagaries of spelling. The first appearance of Brazil in geography seems to be, so far as reported, south of west of Limerick on the 1325 map of Dalorto.

Was it thence that the "grain" of 1193 and 1198 was supposed to have come? It can hardly be an error for dyes or dye woods, though both grain and dye wood may have been associated with the idea and name of Brazil, as we still write both India-ink and India-rubber.

W. H. Babcock

CONCERNING GOVERNMENT APPLICATION BLANKS

To the Editor of Science: In former times when one wished to institute a comparison between the various classes of liars, he was accustomed to say "he lies like a horse-thief," or "he lies like a tombstone." Now, however, those of us who are connected with the teaching profession are given to saying "he lies like a testimonial."

It seems a little too bad that one's natural tendency towards mendacity should be accelerated by no less a person than Uncle Sam. Some time ago I was asked to fill out a blank for an applicant for a teaching position in the Philippine Islands, and among other questions asked me were the following:

8. Is the applicant now, or has he ever been, addicted to the use of intoxicating beverages, morphine or opium?

14. Can you state positively that the applicant's character is unimpeachable, and his reputation for sobriety and morality unquestionably good?

The printed directions state that all questions must be answered and that to say "I don't know" is unsatisfactory. Now I feel confident that the young lady who did me the honor to ask me for a testimonial has not been addicted to the use of intoxicating beverages, morphine, or opium; but I could not make this statement as a positive fact about her or any other acquaintance of mine. Again, I believe the applicant's character to be unimpeachable, but I can not state positively that such is the case. This is a world of surprises and disappointments. I am most optimistic, but not sufficiently so to answer these questions in the affirmative. May we not hope that our new president-elect will take measures to relieve the tender consciences of college professors from the great strain that these government blanks put upon them?

James S. Stevens

University of Maine

SCIENTIFIC BOOKS

Richtlinien des Entwicklungs- und Vererbungsproblems. By Alfred Greil, Professor of Anatomy, Innsbruck. Jena, Gustav Fischer. 1912. 2 parts.

The crude evolutionism of Bonnet gave place to the epigenesis of C. F. Woeff, and this, too indefinite to give sufficient explanation of the phenomena of cell differentiation, adaptation and inheritance, in turn was supplanted by a newer preformationism, at first

also rather crude, but later becoming more and more refined, until finally it has become almost if not quite metaphysical. To Professor Greil, however, preformationism in any of its forms is a stone of stumbling and a rock of offense, and in the two volumes now before us he attempts to recall the feet of the faithful to the paths of epigenesis, by what he terms, with insistence, a formal or descriptive analysis of the phenomena of development.

He starts, however, with a basic proposition, "the true and fundamental principle of rational comparative embryology," which he expresses in the words of Haeckel, "Aus Gleichartigem Ungleichartiges." He is thus an epigenesist of the epigenesists and his method of analysis is to proceed from this assumed truth to reconstruction of the embryological history. The first part of the treatise is practically a reprint of a paper recently published in the *Zoologische Jahrbücher*[1] and is a description of the phenomena of development as seen by a thorough-going epigenesist, who is also a firm believer in the biogenetic law. In the second part special problems, such as adaptation and variability, inheritance and sex-determination, are similarly surveyed and in a somewhat extended appendix the various theories of Roux, R. Hertwig, Rabl, Mehnert, Kassawitz, Fick and Godlewski are reviewed and criticized, with the same richness of dialectic that pervades the entire work.

For the author wields the pen of a ready writer, which unfortunately frequently leads him into unnecessary repetitions and verbosities, which extend over seven hundred pages what might have been clearly and forcibly presented in perhaps half the space, to the greater comfort and satisfaction of the reader. But even with due allowance for redundancies, the ground covered is so extensive as to preclude the possibility of a review or even a bare enumeration of the various questions discussed, and it must suffice to repeat that the main thesis of the work is the all-sufficiency of epigenesis. That is the one and only power, and formal analysis is its prophet. Professor Greil presents a strong case, but it must be confessed that he does not and, indeed, in the present state of our knowledge, he can not yet remove the difficulty that has forced so many thinking zoologists into preformationism, namely, an explanation of how differentiation is possible by epigenesis. One may glibly talk of cellular interaction, of effects produced by quantity and quality of the food and by the outside environment, and of the determination resulting for the chemical constitution of the ovum, but until we have concrete evidence of how these or other factors act in the production of differentiation epigenesis will continue to be no explanation. And, after all, if the last named of the above factors be admitted, is it not merely carrying preformationism back to its ultimate limits and making it identical with epigenesis?

J. P. McM.

[1] A. Greil, "Ueber allgemeine Richtlinien des Entwicklungs- und Vererbungsprobleme," *Zool. Jahrb.*, Bd. XXXI., Abt. für allgem. Zool. und Physiol. der Tiere, 1912.

Origin and Antiquity of Man. By G. Frederick Wright, D.D., LL.D., F.G.S.A. Oberlin, Ohio, Bibliotheca Sacra Company. 1912. Pp. xx + 547. Illustrated.

As an introduction Professor Wright discusses the origin and antiquity of the earth. He inclines toward a very moderate estimate of the length of geologic time and hence of the human period, which began when man became a tool-user. To him the ancient civilizations of Babylonia, Egypt, Crete and Central Asia were of a high order. These rare blossoms in the springtime of history were each nurtured by exceptional geniuses instead of being the product of a gradual unfolding.

The diversity of languages is invoked as an aid in the measurement of man's antiquity. In view of the rapidity with which children when isolated invent a language of their own, the author believes the evidence of an extremely great antiquity of the human race drawn from the diversity of language at the dawn of history to be far from conclusive.

In the chapter on the "Origin of the Races of Europe" (p. 105), the author states that

the stone implements of the Scandinavian shell heaps "have usually been polished and sharpened by rubbing; this justifying their assignment to the 'smooth stone age.'" The fact is, artifacts of polished stone characterize a later stage and not the early shell-heap phase of the neolithic. Neither do the "chipped flint daggers of exquisite form" and the perforated diorite axes (pp. 125–126) come from the "kitchen middens," but from the stone cist burials of a later epoch. The statements that the Cro-Magnon race is of neolithic age (p. 115) and that it did not appear until after the mammoth had become extinct (p. 116) would not be admitted by the best authorities. Cro-Magnon is paleolithic and the mammoth lived on until the close of the Magdalenian, as attested by the mural art of the caverns, especially at Font-de-Gaume; and hence was a contemporary of the Cro-Magnon race. In the same paragraph by inference one is led to suppose that the engraved figure of a reindeer from Thayngen is the work of a neolithic craftsman; when on the contrary it is paleolithic.

As might be expected of Professor Wright, much space is devoted to man and the Glacial period, not only in the old world, but also in the new. His estimates of the length of time that has elapsed since the beginning of the Glacial period are moderate. He believes that the Glacial period was practically a unit, there being four phases instead of four distinct epochs, thus differing from some of the most noted living glacialists. The cause of the Glacial period is assigned to land elevation and its disappearance to a subsidence, factors which probably played a rôle in the great climatic drama, but which might have been correlated with other factors such as the changing condition of the sun itself and in the atmosphere.

But little space is given to cultural and somatic evolution, in which field many important results have recently been achieved. The Magdalenian polychrome frescoes on the cavern ceiling at Altamira are referred to as of Aurignacian age, an error into which Sollas ("Ancient Hunters") also fell.

The author's point of view might possibly be best reflected in a few quotations: "Our earliest knowledge of man is of a being fully formed and in possession of all the faculties of his kind" (p. 389). "On the important question of man's first arrival on this planet we may for the present possess our minds in peace, not a trace of unquestionable evidence of his existence having been found in strata admittedly older than the Pleistocene" (pp. 341–2). "The simple arithmetical calculations made above show that when once started, the dispersion over the world, the diversification of the races, the differentiation of languages, and the development of ancient civilization may easily have come about in the course of four or five thousand years, if not in half that time, and that the extension of prehistoric time for eight thousand years affords superabundant opportunity for the growth and development of all the peculiarities and institutions of man as first made known to us at the dawn of history" (p. 493). "The antiquity of man therefore so far as the question depends upon his connection with the Glacial epoch, is not proved to be, even when we allow a generous margin, greater than twelve or fifteen thousand years" (p. 494).

The chapter preceding the "Summary and Conclusion" treats of "The Biblical Scheme." The work has the welcome merit of an engaging style, possessing to a degree the charm of the author's personality. Another attractive feature is the "Appendix" of copious notes and references.

George Grant MacCurdy
Yale University

SPECIAL ARTICLES

NEW AND EXTINCT BIRDS AND OTHER SPECIES FROM THE PLEISTOCENE OF OREGON

Many years ago I published in the *Journal* of the Academy of Sciences of Philadelphia an account of the fauna of the Oregon desert region during Pleistocene time. This account was based upon a large collection of fossils sent me for the purpose by the late Professor E. D. Cope, who, with his assistants and a

few other naturalists, had brought this valuable material together. By far the greater part of this consisted of the fossil bones of birds, the mammals and fish having been described by Professor Cope in *The American Naturalist* and elsewhere.

The results of my share of the work have long since passed into the literature of the subject; and, as these are fully set forth in my academy memoir, they need not be especially reviewed in this place. It may only be noted that I announced, for the first time, the discovery of a long list of birds, based on the fossils referred to, the majority of which coincided with species and genera of existing forms, while a somewhat formidable array were extinct and new to science.

At the time my examination was made, the skeletons of existing birds at my command were entirely inadequate for the purposes of making reliable diagnoses and references. During the past twenty years, however, such material has been vastly increased in our museums, especially in the U. S. National Museum, and for the use of this in the present connection I am much indebted.

Several years ago, what may be collectively designated as the Cope collection from the aforesaid region was purchased by the American Museum of Natural History in New York City for its paleontological department; and only a few months ago Dr. W. D. Matthew, the curator of that department, shipped me to Washington the entire collection for the purpose of a complete revision. This task is now practically completed, and the object of the present article is simply to publish an advance abstract as an announcement of the additional birds of the region in question, the fossil remains of which I have found to exist in the aforesaid collection, and a small collection from the same localities (Silver and Fossil lakes), which belongs to the U. S. National Museum. The new species will be fully described in the forthcoming contribution on the subject, accompanying which will be found upwards of 600 figures illustrating the entire avifauna of the Pleistocene of Oregon, in so far as their fossil remains are concerned.

The list is as follows, each species in it, with one exception, being announced for the first time:

1. *Colymbus parvus* (extinct).
2. *Podilymbus magnus* (extinct).
3. *Centrocercus urophasianus.*
4. *Mergus americanus?*
5. *Mergus serrator.*
6. *Mergus* sp.?
7. *Marila americana?*
8. *Marila valisineria.*
9. *Marila marila.*
10. *Marila affinis?*
11. *Marila collaris?*
12. *Charitonetta albeola.*
13. *Histrionicus histrionicus.*
14. *Polysticta stelleri.*
15. *Erismatura jamaicensis.*
16. *Branta c. hutchinsi?*
17. *Branta c. minima?*
18. *Branta bernicla.*
19. *Olor columbianus.*
20. *Olor buccinator.*
21. *Olor matthewi* (extinct).
22. *Ardea herodias.*
23. *Botaurus lentiginosus.*
24. *Aquila chrysaëtos.*
25. *Haliæetus leucocephalus.*

Erismatura jamaicensis has been previously announced by Mr. L. H. Miller in the *Bulletin* of the Academy of Natural Sciences of California. The three new extinct birds found, and the descriptions of them, will appear when the memoir is published.

R. W. SHUFELDT

November 18, 1912

PROCEEDINGS OF THE ENTOMOLOGICAL SOCIETY OF AMERICA

THE seventh annual meeting of the Entomological Society of America was held at Cleveland, Ohio, December 31 and January 1, in the auditorium of the Normal School. The meetings were all well attended and enthusiastic. The following papers were presented:

C. BETTEN, Lake Forest University: *An Interesting Feature in the Venation of Helicopsyche, the Molannidæ and the Leptoceridæ.*

In the trichopterous genus *Helicopsyche* radius of the fore wing is found in primitive condition, *i. e.*, R_1 is simple and the sector is dichotomously branched. The homology is but slightly obscured

by the fact that the cross vein *r–m* is in direct line with the distal part of R_4, making the latter appear to arise from *M*. It is suggested that the same interpretation should be made in the case of the Molannidæ and the Leptoceridæ. In these families R_5 has more definitely assumed relations with *M*, with which vein its distal part may be wholly fused. This interpretation is based not only on comparison with *Helicopsyche*, but also upon the fact that it leaves the "corneous point" within cell R_4, where it occurs in all other families if it occurs at all. The venation of the hind wings of these forms is similarly interpreted.

LUCY W. SMITH, Mt. Holyoke College: *Mating and Egg-laying Habits of Perla immarginata.*

In introduction the paper gives a general description of the method of keeping adult stoneflies under observation in captivity, and of handling their eggs. This is followed by a detailed account of the genital armature, copulation and egg-laying habits of a single species, *Perla immarginata.*

ALVAH PETERSON, University of Illinois: *Head and Mouth Parts of Cephalothrips yuccæ.*

A preliminary report on the asymmetry of the mouth-parts of Thysanoptera. A detailed description of the anatomy of the mouth-parts and head capsule of *Cephalothrips yuccæ*, a species belonging to the suborder *Tubulifera*, was given. Numerous details and parts heretofore undescribed as to mandibles, hypopharynx, epipharynx, arms of tentorium, etc., were shown. Similar observations were made on *Anthothrips verbasci* in order to verify results found in *Cephalothrips yuccæ.*

Comparing the work done by H. Garman on *Limothrips cerealium*, a species of Terebrantia, with the work done by Muir and Kershaw on a species of Tubulifera, a difference in interpretation exists as to whether the asymmetrical parts are mandibles or maxillæ. Muir and Kershaw interpret the asymmetrical parts as maxillæ. Observations made by the writer on two species of Tubulifera verifies their position in general. The writer expects to continue his observations on species of the suborder of Terebrantia to determine if possible whether the interpretation of H. Garman is correct or not.

J. E. WODSEDALEK, University of Wisconsin: *Life History and Habits of Trogoderma tarsale, a Museum Pest.* Read by title.

LEONARD HASEMAN, University of Missouri: *Life Cycle and Development of the Tarnished Plant Bug, Lygus pratensis Linn.* Presented by the secretary.

Owing to the very serious injury to peach and pear in the early spring which seemed to be due to the work of the tarnished plant-bug, the writer has undertaken a careful study of the life cycle, habits and development of this insect. The work has been carried through the late summer and fall months and will be continued throughout the following spring and summer.

In this work it has been found that the tarnished plant-bug breeds largely upon various flowering weeds, such as wild asters, daisies and mare's tail (*Erigeron canadensis*). The tarnished plant-bug deposits its eggs in the blossoms of the host plant and not in the tissue of the leaves or stems. These eggs hatch in from five to seven days and the insect passes through five distinct nymphal stages in its development in the place of four, as other writers have maintained. The insect remains in each nymphal stage for about the same length of time and completes its growth in from thirty to thirty-five days.

VICTOR E. SHELFORD, University of Chicago: *The Ontogomy of Elytral Pigmentation in Cicindela.*

The pigment develops in the form of a faint pattern, somewhat variable, but with certain lighter areas occurring in the same general position in several species. These lighter areas lie between the tracheæ and in certain transverse bands; their position corresponds to those of certain white markings of Ethiopian and Oriental species.

N. L. PARTRIDGE, University of Illinois: *The Tracheation of the Pupal Wings of some Saturnians.*

A method of preparing permanent mounts of lepidopterous pupal wings was described. The pupal wings were removed in the customary manner and the specimens secured, floated upon clean water to straighten the wings and remove any dirt which might adhere to them. Then they were placed on a clean, untreated glass slide, smoothed and allowed to dry, without further treatment. The result was a transparent mount showing all the tracheoles as well as the tracheæ. Some of these mounts were used as lantern slides, giving clear images on the screen.

It was shown that a greater amount of variation was found in the pupal wings than in the adult wings. The homologies between the tracheæ and veins, of the specimens shown, was indicated.

L. B. WALTON, Kenyon College: *Studies on the Mouth-parts of Rhyparobia maderiæ (Blattidæ)*

with a consideration of the Homologies existing between the Appendages of the Hexapoda.

The question as to the homologies existing among the paired appendages of the Hexapoda has received attention from various investigators, and in particular from Hansen, Heymons, Borner, Verhoeff and Escherig, none of whom, however, have progressed far toward a satisfactory solution of the problem. In general it has been accepted that the stipes and mentum corresponded to the thoracic and abdominal coxæ while the maxillary and labial palpi were equivalent to the trochanter, femur, etc., of the functional leg.

Studies on *Rhyparobia maderæ*, the "giant cockroach" from Panama, particularly of 10 mm. and 12 mm. embryos, as well as other investigations in connection with the appendages of the Thysanura, make it evident that the typical appendage (mouth parts, thoracic, abdominal, caudal) of the Hexapoda consists of seven definite areas best represented by the maxillæ with the galea, lacina, ectostipe,[1] endostipe, ectocardo, endocardo and palpus. Furthermore, the palpus should be homologized with the stylus of the thoracic and abdominal coxæ and not with the functional leg, inasmuch as both palpus and stylus are appendages of homodynamous areas (ectostipe, ectomentum, meron) while the leg is an appendage of the area (endocoxa) corresponding to the endostipes.

The facts noted suggest the origin of the biramose appendage of the Hexapoda directly from the parapodium of the Polychæta, the notopodium and neuropodium arising in connection with the dorsal and ventral bundles of setæ and corresponding to the outer (ectal) and inner (endal) groups of sclerites as outlined above. It would thus appear that the Arthropoda are a polyphyletic group, and that the relationship between the appendages of the Hexapoda and Crustacea is a more remote one than generally accepted in connection with the studies of Hansen and Borner.

The historical development of the problem as well as the presentation of the facts which would seem to establish the views here advanced, will appear in the completed paper, of which this is a partial summary.

JAMES ZETEK, Sanitary Commission Canal Zone: *Determining the Flight of Mosquitoes.* Read by title.

WILLIAM A. RILEY, Cornell University: *Some Sources of Laboratory Material for Work on the Relation of Insects to Disease.*

The demand for at least elementary courses on the relation of insects to disease brings up the question as to available laboratory material. There is comparatively little difficulty in obtaining the parasitic mites, ticks, lice, house-flies, mosquitoes and fleas in their various stages, but it is usually assumed that most of the pathogenic Protozoa are tropical species and that nothing can be substituted for them in laboratory work. As a matter of fact, a number of insect-borne Protozoa and worms occur in this country and, together with other blood parasites whose life-history is less better known, are available for laboratory work. The species discussed were *Trypanosoma lewisi*, a widely distributed parasite of brown rats; *Trypanosoma rotatorium* from the frog; the related *Crithidia* from the "sheep tick"; *Herpetomonas* from the house-fly; *Monocystis* from the seminal vesicles of the earthworm as introductory to the study of the Hæmosporidia; *Lankesterella ranarum*, *Hæmogregarina* sp.; *Proteosoma*, *Halteridium*, *Babesia hilaria* in the blood of the crow and English sparrow, and *Dipylidium caninum*, the double-spored tapeworm of dogs, cats and man.

Y. H. TSOU and S. B. TRACKER, University of Illinois: *The Homology of the Body Setæ of Lepidopterous Larvæ.*

This paper consisted (1) of a statement of the difficulties involved in homologizing the body setæ of these larvæ, (2) of a consideration of the serial homology of the setæ of the different segments and (3) of the specific homology in the larger groups. Greek letters were employed to designate the setæ in order to obviate the confusion which has arisen from the use of numbers in different ways by different authors. The prothorax of *Hepialus* was shown to represent the primitive arrangement of setæ and was used as a type for determining the homology of the setæ on the different segments. The authors had studied many species and gave figures of four: *Hepialus lectus* and *H. humuli* of the Jugatæ, *Pseudanophora arcanella* of the Tineidæ and *Mamestra picta* of the Noctuidæ. Each of these was compared with the type, segment for segment. This is the first time the setæ of the prothorax have been homologized with those of the other segments.

[1] The prefixes "ecto" and "endo" have been utilized in an attempt to establish a better nomenclature, while minor changes have been made in the terminology of older parts, *e. g.*, "ectostipes" is a more cumbersome term than "ectostipe."

Anna H. Morgan, Mt. Holyoke College: *Eggs and Egg-laying of May-flies.*

This study of May-fly eggs was made to determine the relative fecundity of different species. This led to the study of a series of elaborate sculpturings found upon the chorion. In several species the chorion bears long thread-like extensions which terminate in viscid spheres or disks. These seem to help buoy up the eggs. Threads two and three inches long were found. In nature these threads are probably entangled in sticks and vegetation and this prevents the eggs from being covered by silt. In the ovaries of half-grown nymphs these structures are well defined and are of aid in connecting up the life histories where rearing is impossible.

Herbert Osborn, Ohio State University: *Notes on Cicadidæ with Especial Reference to the Ohio Species.*

Cicadas constitute a conspicuous element in insect fauna and their relation to varied forest conditions is discussed especially for the species occurring in Ohio. The origin and function of the tympanal organs present problems for study and the suggestion is made that this structure is primarily a secondary sexual character functioning in sexual excitation and only incidentally a sound-producing organ.

Frank E. Lutz, American Museum of Natural History: *On the Biology of Drosophila ampelophila.*

This insect is remarkably useful in laboratory work, since it can be kept going throughout the year on bananas as food and its short life-cycle (about ten days to two weeks) enables one to get a large number of generations. Sexual difference characterizes the insect. Not only do the sexes differ in adult color and structure, but they differ in the duration of the immature stages, in their reactions to light and the age at death.

E. P. Felt, State Entomologist, New York: *Observations on the Biology of a Blow-fly and a Flesh-fly.*

A study of *Phormia regina* Meign. and *Sarcophaga georgina* Wied. was undertaken primarily for the purpose of obtaining data which could be used as a basis for estimating the period a human body had laid exposed to the elements in midsummer. Our knowledge of these two species is summarized and original data are given on the habits and duration of the various stages under known climatic conditions. The egg of *Phormia* and the three larval stages and puparium of both species are described and a bibliography of each appended.

Edith M. Patch and William C. Woods, Maine Agricultural Experiment Station: *A Study in Antennal Variation.* Read by title.

Alex. D. MacGillivray, University of Illinois: *Propharynx and Hypopharynx.*

The pharynx after entering the occipital foramen makes a distinct bend toward the mouth. In the region of the clypeus it divides transversely, one half passes to the clypeo-labral side, the other half to the labial side of the mouth, while folds extend along each lateral margin and unite with the mandibles and maxillæ. The name of propharynx is proposed for the portion lying adjacent to the clypeo-labral part of the mouth and hypopharynx is used for the portion lining the labial portion. The propharynx consists of three parts: frontal lobe, epipharynx and fulcrum. The frontal lobe is usually wanting in sucking insects, the epipharynx is modified into a tongue or piercing organ and the fulcrum into a cuticular supporting plate. In the muscids the epipharynx and fulcrum are located outside of the mouth, the proximal end of the fulcrum is attached to the distal margin of the labrum. The hypopharynx also consists of three parts: lingua, superlingua and pharangial sclerites.

T. L. Washburn, State Entomologist, Minnesota: *A Few Experiments in Photographing Living Insects.*

Thomas J. Headlee, New Jersey Agricultural Experiment Station: *Some Facts Regarding the Influence of Temperature and Moisture Changes on the Rate of Insect Metabolism.*

While connected with the Kansas State Experiment Station at Manhattan, the writer found by subjection of different groups of the southern grain louse (*Toxoptera graminum* Rodani) to various constant temperatures under constant atmospheric moisture conditions and other groups to various constant percentages of relative humidity under constant temperature conditions: (1) that the rate of increase in metabolism for each 10° F. increase in temperature, starting at 50° F., decreases as the optimum temperature is approached, and that while the metabolism of degeneration becomes more rapid after the optimum is passed the rate of growth is retarded; (2) that a variation of from 60 to 62 per cent. in atmospheric moisture does not affect the rate of metabolism when the creatures have an abundant supply of succulent food.

Similar tests of the effect of temperature on the rate of metabolism in *Lysiphlebus tritici* Ashm. and of the effect of temperature and moisture on the rate of metabolism of the chinch bug (*Blissus leucopterus* Say) infected and uninfected by the chinch-bug fungus (*Sporotrichum globuliferum* Speg.) gave similar results.

J. T. ABBOTT, Washington University: *The Strigil in Corixidæ and its Probable Function.* Read by title.

EDNA MOSHER, University of Illinois: *The Anatomy of some Lepidopterous Pupæ.* (Presented by Mr. Alvah Peterson.)

Figures of pupæ of three species were shown; also figures of the pupæ with the cases dissected away so as to show the parts underneath. Considerable difficulty has been encountered in homologizing the pupal structures from the external appearance, particularly in the case of the fixed parts of the head and the appendages of the head and thorax. The leg cases were shown to be a frequent source of error. Instead of showing externally only the cases for the tibiæ and tarsi, as Scudder claims is the case in the butterflies, certain forms show the femur cases and either the whole or part of the coxal cases in certain pairs of legs. What Packard calls the paraclypeal pieces, were shown in these forms to contain functionless mandibles which had their distal margins toothed in the case of *Lymantria.*

This detailed anatomical study is to be made the basis for a phylogenetic and taxonomic arrangement of the Lepidoptera based on an examination of the characters of the pupæ.

CHARLES K. BRAIN, Ohio State University: *Some Anatomical Studies of Stomoxys calcitrans Lin.* (Introduced by Professor Herbert Osborn.)

The external mouth-parts and digestive system of both sexes of this species are identical in structure, and both sexes suck blood. The external mouth-parts consist of maxillary palpi and proboscis; the latter consisting of labrum, hypopharynx and the labium.

The digestive system consists of proboscis, pharynx, œsophagus, proventriculus, intestine, rectum and the appendages, viz., salivary glands, sucking stomach and Malpighian tubes. The two Malpighian tubules of the left Malpighian tube have much thickened ends, which lie dorsally. Those of the right side have no such thickened ends. The male reproductive organs consist of a pair of spherical testes which appear orange-colored in dissections, owing to their pigmented sacs, their ducts leading into the common vesicula seminalis, the ejaculatory duct and the penis.

The female reproductive organs consist of the ovaries, oviducts, uterus and ovipositor, with the appendages, the uterine glands and the receptacula seminis.

S. W. BILSING, Ohio State University: *Observations on the Food of Spiders.* (Introduced by Professor Herbert Osborn).

Spiders are known to feed upon insects, but exact records of kind and quantity of food for particular species are very meager. Extended observations and records were made during the summer and fall of 1912 and data from some of these are presented. As an example of the records given, grasshoppers constituted 39 per cent. of the food of *Miranda aurantia*, 59 per cent. of the food of *Agalena nævia* and 22 per cent. of the food of *Aranea trifolium* during the period under observation.

HERBERT OSBORN, Ohio State University: *Observations on Insects of a Lake Beach.*

The insect fauna of the Cedar Point Beach of Lake Erie is discussed with reference to its derivation and adaptation for the conditions presented. The insect drift, the migrant and the resident members of the association are separated and records of species in each group given.

C. H. TYLER-TOWNSEND, Government Entomologist of Peru: *The Species-Status and the Species-Concept.* Read by title.

C. H. TYLER-TOWNSEND, Government Entomologist, Peru: *A New Application of Taxonomic Principles.* Read by title.

The annual public address of the society was given on Wednesday evening, January 1 in the auditorium of the Normal School by:

DR. PHILIP P. CALVERT, University of Pennsylvania: *An Entomologist in Costa Rica.*

There was briefly recounted certain physical and meteorological features of that country which render it very favorable for the study of the influence of these factors on the distribution and habits of plants and animals. A few localities, selected from those in which the speaker had worked during the year from May, 1909, to May, 1910, were described and their fruitfulness illustrated by some of the discoveries made of the habits and life histories of the Odonata (dragonflies) obtained therein.

The following officers were elected for the ensuing year:

President—C. J. S. Bethune.

First Vice-president—Philip P. Calvert.

Second Vice-president—W. M. Marshall.

Secretary-Treasurer—Alex. D. MacGillivray.

Additional Members of the Executive Committee—Herbert Osborn, C. P. Gillette, V. L. Kellogg, J. G. Needham, C. T. Brues and Nathan Banks.

Member of Committee on Nomenclature for three years—E. P. Felt.

ALEX. D. MACGILLIVRAY,
Secretary

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

THE eighty-fifth regular meeting of the Botanical Society of Washington was held at the Cosmos Club, Tuesday evening, January 7, 1913.

The following scientific program was presented:

DR. DAVID GRIFFITHS: *Performances in Species of Opuntia.* (Illustrated with lantern slides.)

This paper will be published in the near future as a bulletin of the Bureau of Plant Industry.

MR. J. B. NORTON: *Some Interesting Facts Concerning the Genus Asparagus.* (Illustrated with lantern slides.)

This paper gave a review of the interesting features connected with the work of breeding a rust-resistant variety of asparagus. *Asparagus officinalis* has never been found to be completely immune to the attacks of its rust, *Puccinia asparagi.* Plants nearly immune to the destructive summer stages show no resistance to the æcidial stage of the fungus. Resistance seems to be due to morphological causes. Related species are attacked by the rust, but the members of other sections of the genus seem immune. The genus *Asparagus* and its relatives are entirely limited to the old world, the majority being African. A study is being made of the relationships of this group and many new characters based on the manner of growth, roots, stems, leaf scales, cladodes, etc., have been found. The arrangement of the stomata on the cladodes is very characteristic in the various groups. The old genus *Asparagus* contains several very distinct groups of species entitled to generic rank.

Only one hybrid form of known parentage has been secured, a cross between *A. officinalis* and *A. davuricus.* Many other combinations have failed to produce seed. Asparagus grows rapidly—some species average nine inches per day. The seed germination takes from 12 days with *officinalis* to 60 or more days with some African species. Several new ornamental forms were described.

C. L. SHEAR,
Corresponding Secretary

THE TORREY BOTANICAL CLUB

THE meeting of November 12, 1912, was held at the American Museum of Natural History. President Burgess presided.

The announced scientific program consisted of an illustrated lecture by Dr. J. J. Levison on "Tree Problems of our City."

THE meeting of November 27, 1912, was held in the laboratory of the New York Botanical Garden. Vice-president Barnhart presided.

The first paper was by Dr. W. A. Murrill, on "The Polypores of the Adirondacks." This paper has been published in full in the *Journal of the New York Botanical Garden,* 13: 174–178, November, 1912.

The second number was given by Dr. A. B. Stout. The subject of his discussion was "The Distribution of Tissues in the Root Tip of *Carex aquatilis.*" Several photomicrographs of sections of root tips were exhibited, and drawings were made to illustrate particular features in the arrangement of the tissues.

THE meeting of December 10, 1912, was held at the American Museum of Natural History. President Burgess presided.

On the motion of Dr. Southwick the treasurer was authorized to draw an order for the sum of twenty dollars in favor of Dr. William Mansfield to cover the dues as the representative of the club to the council of the New York Academy of Sciences.

The paper of the evening was on "Diatoms," by Dr. Marshall A. Howe. It was a semi-popular account of the principal structural and morphological features of diatoms, their distribution and habitat, their geological interest and importance, the various economic uses of diatomaceous earths, etc. The talk was illustrated by about seventy-five lantern slides from the collection of the late Charles F. Cox. Many of the photographs shown were made under high powers of magnification and they brought out with much distinctness the secondary markings and other minute structural details of the walls of various types of diatoms.

B. O. DODGE,
Secretary

SCIENCE

FRIDAY, FEBRUARY 28, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE CARNEGIE INSTITUTION OF WASHINGTON[1]

PRESENT STATUS OF THE INSTITUTION

ALTHOUGH the institution is quite young and must be considered as still, to some extent, in its formative stages, this first year of the second decade of its history marks an epoch worthy of something more than passing notice. During this year, to a degree hitherto impracticable, there has been opportunity for an objective view of the meaning of the extensive and varied experience, acquired by the institution, of the principles which have guided its development, and of the limitations, difficulties and dangers which may beset its future progress. During this year also, to a greater degree than hitherto, have appeared evidences from widely divergent sources of an increasing public tendency to take an objective view of the plan, scope, organization and development of the institution and to measure its efficiency by the results of its investigations already published or under way. From these objective views it appears that, in spite of a great diversity of opinion as to what research is and how it should be carried on (a diversity which seems destined to continue indefinitely), there is now a consensus of opinion that the institution has established its position and demonstrated the practicability of the conduct of effective research in establishments wholly devoted thereto, separate and apart from other establishments whose functions are primarily and commendably agricultural, charitable, com-

[1] Extracts from the report of the president for the year ending October 31, 1912.

mercial, educational, governmental, political, religious or social. Thus, in general, it may be said that, as regards internal and external relations and interrelations, the institution in its chosen field of activity has now reached a status approximating to stability of adjustment, wherein definiteness of aim, continuity of effort and concentration of energy and resources may be more productively applied than heretofore.

But while the work proper of the institution, namely, work of research, is in a satisfactory condition, as much may not be said of the adventitious work incident especially to the administrative office. For although this latter work is sometimes instructive and occasionally useful, it is generally fruitless and often excessively wasteful of time and energy which might otherwise be turned to better account. This work involves a vast correspondence concerning an endless variety of subjects and particularly concerning an endless variety of objects for which funds might be spent. In its higher phases it is the work of an intelligence office and may be accepted as a not unworthy though unintended function of the institution; in its lower phases it is in need of curtailment in the interests alike of all concerned.

The time for a detailed, or even summary, account of this highly complex and to some extent psychologically important experience has not yet arrived. Such an account must be left to historians interested in the evolution of institutions or to analysts, like De Morgan, in search of a mine of materials for a new "Budget of Paradoxes." It is plainly the part of wisdom, however, not to wait for verdicts of the historian and the analyst, but to make use of such inductions as may be safely drawn, not only from the experience just referred to, but also from that gained in the work proper to the institution. Most of the theories, ideas and sentiments involved are subject to the tests of statistical treatment which determine with sufficient accuracy the more fruitful methods of procedure. Of the many inductions which may be thus drawn out of the experience of the institution a few may be here set down as indicative of existing conditions and tendencies.

It is in evidence—

1. That there are the amplest room and the amplest opportunity for research establishments without danger of encroachment on establishments founded for other purposes; that it is not difficult for the institution to find appropriate ways in which to apply its income; that there are, in fact, in plain sight, ten times as many worthy, practicable subjects of research and ten times as many worthy investigators as the income of the institution can advantageously subsidize.

2. That there are many investigations of such magnitude and difficulty that they can not be carried on economically and effectively except by men untrammeled by other occupations. The common notion that research demands only a portion of one's leisure from more absorbing duties tends to turn the course of evolution backwards and to land us in the amateurism and the dilettantism wherein science finds its beginnings.

3. That it is inimical alike to the interests of society and to those of the institution to look upon it as a mere disbursing agency designed to meet emergencies or to supply deficiencies of other institutions and of individuals. The widely spread impressions that the income of the institution is sufficient to meet the aggregate of such emergencies and deficiencies, and that the institution can undertake to play the rôle of a special providence and thus anticipate the collective needs of deserving

individuals and organizations, have no foundations in fact.

4. That while there may be wisdom in a multitude of counsels, it becomes increasingly difficult of access as the multitude enlarges and is generally obscured, if not hidden, by a conflict of opinions. The current popular impression that discoveries and advances may be favorably promoted by the patient examination of a vast aggregate of miscellaneous suggestions is a fallacy abundantly demonstrated by the probably unequaled data available to the institution.

5. That it is neither practicable nor advantageous for the institution to undertake to perfect inventions, to secure letters patent for them, to defend inventors in suits at law, or to exploit successful inventions. The objects of the inventor are primarily egoistic and hence secretive; the objects of the institution are primarily altruistic and hence non-secretive; their divergence is so great as to render them mutually exclusive under existing conditions. The distinction between invention and investigation is rarely understood and is not always easily drawn. They are indeed closely allied; for the inventor is often compelled to make investigations and the investigator is often compelled to devise inventions. It should be said also that the egoism of the inventor which leads him to secretiveness and to seek state privileges through patent rights has its correlative in the desire of the investigator to secure priority of discovery and publication. The distinction is one of reversed attitudes and objects. The inventor is primarily interested in direct personal benefits which may come from the application of facts and principles in the perfection of useful devices, machines and processes. The investigator is primarily interested in the discovery of facts and principles which may be given freely to the world without expectation of immediate application or hope of direct personal benefit. It is claimed, however, that the party of the second part to be considered in all such matters, namely, society, is in general disproportionately the gainer over both the inventor and the investigator. The extensive evidence on this subject acquired by the institution shows clearly that the indirect advantages to the investigator arising from his altruism are generally much greater than the direct advantages to the inventor arising from his egoism. This evidence is, indeed, so convincing as to suggest the desirability, at some future date, of the organization of a department devoted to inventions, which, instead of being protected by patent rights should be protected, if at all, against them. It is plain, in fact, that if society could make use of knowledge now available the labors of the expert inventor could become far more fruitful and far more satisfactory to him than they are at present.

RÉSUMÉ OF INVESTIGATIONS OF THE YEAR

Departments of Research

It is now nine years since the earliest of the departments of research established by the institution were authorized and six years since the latest of them was authorized. This lapse of time has now fully demonstrated that these departments are all engaged in enterprises which, by reason of their magnitudes, were unlikely to be carried out under other auspices. They have grown very rapidly and have become highly productive. All of them tend continually, and in many respects properly, to expand as their several fields of investigation are developed. They thus tend constantly to press closely upon the available income of the institution and hence to become a source of concern by reason of their highly commendable progress. But the

remedy for this paradox does not lie alone in increased expenditures; to an equal extent, at least, it lies in increased efficiency under slowly increasing, or even stationary or decreasing, expenditures. It is a special duty of the man of science to show how more and better work can be done at less cost than has been practicable to his predecessors.

Although these departments of investigation, like the institution as a whole, have fallen short of popular expectations in the rapidity of their growth, it now appears plain, in the light of their actual experience, that this growth has been somewhat too rapid for safety. Along with this rapid growth and with the signal success of these departments in their several fields of research, there are now coming also numerous requests for cooperation with other organizations and with individuals. But while these requests are in general gratifying and often praiseworthy, they present some obvious hazards. There is need, therefore, of constant caution against the dangers of undue expansion and affiliation which lead to dissipation of effort and resources. It should be kept in mind that concentration on definitely limited programs, continuity of effort and energetic assiduity are the factors most essential to progress in the domain of research.

The plan referred to a year ago, of inviting one or two eminent specialists to become associated with each of the departments for limited periods of time, has thus far worked quite advantageously and promises to become increasingly fruitful. Eight such specialists have been connected with the departments during the past year by direct appointment of the executive committee, with varying compensations, as shown in the financial section of this report. Some other research associates have served without compensation and several collaborators have also partaken in departmental investigations or availed themselves of departmental facilities without direct expense to the institution.

As usual, in the president's report, reference must be made to the departmental reports, to be published in full in the current year book, for comprehensive accounts of departmental investigations, publications and plans for future activities, as well as for accounts of the work of departmental associates and collaborators. Only the briefest summaries, indicating some of the salient features of these accounts, are attempted in the following paragraphs.

Department of Botanical Research

The geographical range of the work of this department, which centers in the Desert Laboratory at Tucson, Arizona, has been extended during the past year to include certain portions of the deserts of northern Africa. Thus Dr. Cannon spent the late autumn and early winter of 1911–12 in the deserts of Algeria, while Director MacDougal and his engineer, Mr. Sykes, spent a good share of the winter of 1911–12 in the Lybian deserts. These expeditions enabled the department to acquire extensive information for comparative studies of desert areas, and Dr. Cannon's report on the results of the earlier expedition has been already received for publication.

Studies have been continued also at the Desert Laboratory, at the Carmel Laboratory on the California coast, at Salton Sea, and at various substations where observations are made on the phenomena presented by plants under strikingly varying conditions. The desiccation of the Salton Sea now under observation presents many instructive conditions which are being carefully studied in their climatic, biological and physical aspects. It will be practi-

cable, therefore, in the course of a few years, to furnish something like a detailed history of this remarkable basin, which has now been carefully studied at intervals since its discovery in 1854 by the late Professor N. P. Blake.

One of the most important investigations undertaken during the past year is that of a comprehensive study of the large and highly diversified family of cactus plants. Through the cooperation of Professor N. L. Britton, director of the New York Botanical Garden, and Dr. J. N. Rose, of the staff of the Smithsonian Institution, who have been appointed research associates, it will be practicable, by aid of the facilities of the department, to produce a monographic study of these typical desert plants.

Several volunteer associates and collaborators of the department have participated in departmental researches and contributed to the progress attained therein. Upwards of twenty individuals have taken part in one or more phases of this work.

Department of Experimental Evolution

The advances made by this department during the past year have been chiefly along the lines of studies in cytology, in the chemistry of pigmentation, in the factors of mutation, and in the problems of human heredity. These studies have been carried on by aid of experiments with plants and animals and by aid of rapidly accumulating statistical data concerning human traits and their transmission through successive generations. The director has been able to give much of his time to studies in human heredity by reason of his connection with the Eugenics Record Office, whose work has been liberally supported by Mrs. E. H. Harriman and by Mr. John D. Rockefeller. The experiments of the department proper with plants and animals are thus supplemented very advantageously by the extensive information already acquired by the Eugenics Record Office in respect to human heredity.

Very interesting chemical studies have been carried on by Dr. Gortner, a member of the staff, in respect to the chemical nature of pigments which determine color characteristics, especially of the plumage in birds, of the wool in sheep, and of the skin in men.

Dr. Shull has continued his fertile studies into the heredity of plants, including further investigations into the connection between heredity and environment in the case of corn. These further studies confirm his earlier conclusions and show also that the hereditary traits of different strains are maintained irrespective of environmental influences.

The director calls attention to the need of his department for additional buildings and equipments. A recommendation with respect to this need will be found in a subsequent part of this report.

Department of Economics and Sociology

According to the report of Professor Henry W. Farnam, chairman, the work of this department has now reached such a stage of advancement that the time of its completion depends mainly on the amount of leisure the collaborators may obtain in the near future for consecutive attention to their several contributions to the "Economic History of the United States." By aid of the special appropriation for payment of salaries (made by the board of trustees a year ago), it is now practicable for some of the collaborators to devote part of their time and attention consecutively to this work, and two or three of them will doubtless be able to give at least half-time under this plan during the ensuing year.

The present status of the investigations of the several divisions of the department is set forth in detail by the chairman in his report.

The attention of the trustees is especially invited to a paragraph in Professor Farnam's report calling attention to the desirability of a more permanent organization of this department before its present program of research is completed. He recommends an organization similar to that of other departments of the institution, which would involve the appointment of a salaried director and a permanent staff. The experience of the institution leaves no doubt as to the wisdom of this recommendation on the score of continuity and efficiency for this as well as for other departments of the institution. Further reference to this subject will be made in the budget section of this report.

Geophysical Laboratory

The list of twenty-six publications which have emanated from the geophysical laboratory during the past year, and which are briefly reviewed by the director in his annual report, furnishes the best index of the activity of this establishment. Two specially noteworthy publications of the laboratory have been issued during the year by the institution, namely, No. 157, "High Temperature Gas Thermometry," and No. 158, "The Methods of Petrographic-Microscopic Research." The purpose of the first of these was to give an account of the apparatus and methods for accurate measurement of the critical temperatures incident to mineral combinations; and the object of the second is to place, so far as practicable, microscopic study of minerals upon a quantitative basis. Attention has hitherto been called to this characteristic feature of the investigations of the geophysical laboratory, which is a characteristic feature of all of the advancing sciences. The work already accomplished demonstrates the practicability of achieving this object for the science of mineralogy. This advance requires that special attention be given to accurate measurements of high temperatures and high pressures, as well as to their simultaneous effects upon mineral constituents. Much study, therefore, continues to be given by the laboratory staff to the development of effective apparatus and technique for the measurements essential in this work.

Special attention is called in the director's report to extended studies on quartz and other forms of silica which is the most widely diffused ingredient in rock masses; to further experiments on the conditions of association of the three oxides, lime, alumina and silica, which in addition to being the commonest components of igneous rocks are also incidentally the three principal ingredients of the so-called Portland cement; to mineral sulphides, which are often of great economic importance; and to mineral and rock densities.

Perhaps the most interesting of the more recent investigations of the laboratory are those of the physics and chemistry of active volcanoes undertaken tentatively a year ago and pursued with very gratifying success during the past summer. It has proved practicable for members of the staff to descend into the crater of Kilauea and to collect considerable quantities of gas as it emerged from the liquid lavas of the crater. Specimens of gases were collected in glass tubes without contamination from the air, and these have been brought to the laboratory at Washington for detailed study. There seems little reason to doubt that the phenomena of vulcanism will be ultimately revealed by the methods, appa-

ratus and technique developed by the staff of the laboratory.

Department of Historical Research

Naturally a department devoted to historical research is chiefly concerned with the preparation of publications, and these latter for the department in question may be classified under the head of reports, aids and guides concerning materials relating to American history and under the head of textual publications of documents. Under the first head attention may be called to Professor Marion D. Learned's "Guide to the Manuscript Material relating to American History in German State Archives," No. 150 of the publications of the institution, which has appeared during the year. Two other volumes, namely, publication No. 90A, "Guide to the Materials for American History, to 1783, in the Public Record Office of Great Britain," and publication No. 163, "Guide to the Materials for the History of the United States in the Principal Archives of Mexico," of the institution are now in press. No. 90A has been somewhat delayed by reason of a reclassification to which large sections of the British Public Record Office were subjected after this work had been started by Professor Andrews. Another work in press by the department is Mr. David W. Parker's "Guide to the Materials for United States History in Canadian Archives," publication No. 172 of the institution.

Further progress is reported in respect to the work in charge of Mr. W. G. Leland, of the departmental staff, on materials for American history in the archives of Paris. Search has been made also in several other European cities for sources of American history. The director of the department spent the past summer in Europe and took occasion while there to devote special attention to the materials derivable from the five French-speaking cantons of Switzerland. Assistance has been rendered to the department during the year by several collaborators who have been called by the director to his aid in the preparation of the proposed atlas of historical geography of the United States, to which reference has been made in preceding reports.

Dr. Burnett, of the departmental staff, has been engaged chiefly upon the series of "Letters of Delegates to the Continental Congress," while Miss Davenport, also of the permanent staff, has been occupied nearly continuously in the collection of "European Treaties having a bearing on United States History." These documents promise to furnish much material hitherto inaccessible to students of American history.

Department of Marine Biology

The independent transportation facilities furnished by the staunch new vessel *Anton Dohrn*, and the repairs and improvements to the laboratory completed a year ago, have proved highly advantageous to the department of marine biology. By means of the *Anton Dohrn* the entire Gulf and West Indian region becomes open to investigation by the department. The director records with appreciation a gift to his fleet by Hon. John B. Henderson, of Washington, D. C., of a 23-foot, 6 horsepower launch, which has already proved a very useful adjunct in the diversified work of the department, since many different investigations are carried on simultaneously by different individuals at the laboratory headquarters.

During February and March of the current year the director established a temporary laboratory at Montego Bay, Jamaica, a region which sustains important biological relations to the vicinity of the

Tortugas group of islands. In addition to the director, nine other investigators pursued researches at this laboratory. In May the director and three collaborators visited the Bahamas, making a successful cruise of 570 miles with the *Anton Dohrn*. This expedition was of special aid to Messrs. Drew and Vaughan in their studies concerning oolite deposits and corals.

The director of the department has issued, as No. 162 of the publications of the institution, an additional volume of his series on the jelly-fishes of the world, the title of this volume being "Ctenophores of the Atlantic Coast of North America." Sixteen of his collaborators have presented papers for publication, which will furnish two more volumes of the "Researches from the Tortugas Laboratory."

Department of Meridian Astrometry

After the meridian instrument was brought back from the temporary observatory at San Luis, Argentina, to the Dudley Observatory at Albany, it was thoroughly reexamined to make certain that it had undergone no change on account of the relatively rough handling it necessarily received during this journey from Argentina to America. The reexamination was completed about the beginning of the present fiscal year and proved conclusively that the instrument had suffered no damage in any of its parts. Along with this good fortune to the department and to the Dudley Observatory, this instrument thus becomes noteworthy in the annals of astronomy, for no meridian circle has been so thoroughly proved to retain its stability under such a variety of varying conditions. After the preliminary tests referred to, observations with the instrument were begun on November 13, 1911, and have continued throughout the year, in accordance with the program explained hitherto in the departmental reports.

In the meantime special attention has been given to the reduction of the meridian observations made at San Luis, Argentina. The determination of the two coordinates of stars from this work, namely, right ascension and declination, have proceeded simultaneously. The assignment of stellar magnitudes, however, must await the photometric determinations which have been made at San Luis since the meridian measurements were completed. Late advices from Mr. Zimmer, who has charge of this photometric work, announce that it will be completed by the end of the present calendar year, and he and his assistant are expected to return early next year.

The department reports with great regret the death, on November 19, 1911, by accidental drowning, of Mr. William Hunt, who served initially as Mr. Zimmer's assistant. Mr. Hunt was a young man of much promise, and his untimely loss was a source of shock to his colleagues and a cause of temporary delay to the photometric work.

Much attention has been given by the director of the department and by Mr. Benjamin Boss to studies of stellar motions for which the extensive data accumulated by the department are furnishing evidence. These studies and those made by the solar observatory of the institution, along with corresponding investigations in many other observatories, indicate that the progress of astronomy in the future is to be no less brilliant than it has been in the past.

The great quantity of priceless observational and derived data accumulated by the department rendered it imperative that special provision should be made for their safe storage. Accordingly the executive committee authorized the department to expend, from its last annual allotment, the

sum of $2,000 for the construction of a fireproof vault within the walls of the Dudley Observatory. This vault is now ready for occupancy and the records will be placed therein as soon as practicable.

Nutrition Laboratory

Although investigations began immediately on the establishment of the nutrition laboratory five years ago, the novelty and importance of its field have called for continuous additions to its equipment, while added experience has suggested many improvements in the apparatus used. Thus during the past year two balconies have been added to the calorimeter laboratory, a treadmill designed to measure severe muscular work has been provided for a respiration chamber, and numerous modifications have been made in the calorimeters and respiration apparatus of the laboratory. More detailed studies of the bicycle ergometer, which has hitherto proved so useful in experiments on the metabolism of man during excessive muscular work, have rendered the apparatus available over a wider range of experimentation and with a higher degree of certainty than hitherto. The importance and success of the experiments already undertaken at the laboratory have created a widespread interest in the medical profession, and this interest has led to many cooperative investigations undertaken during the past year. The novel equipment of the laboratory has been the subject of much inquiry also, and many investigators from other laboratories have sought to secure copies of the apparatus used and to learn more of the technique developed by the director and his staff.

One of the most interesting of the many investigations under way during the year is that of the metabolism of a subject who underwent a prolonged fast, extending to thirty-one days without food, and who drank only distilled water during this time. This investigation required the cooperation of a number of chemical, pathological and psychological experts. A detailed report on this elaborately observed experiment is at present in preparation. Another noteworthy investigation of the year is that on metabolism during severe muscular work, undertaken by Dr. E. P. Cathcart, of the University of Glasgow, who was a research associate of the institution during the winter of 1911–12. Amongst other important results of the latter research is the measure it affords of the mechanical efficiency of man. An account of this investigation is likewise in preparation for publication.

In addition to the numerous papers which have appeared in current journals from the laboratory, two volumes, Nos. 166 and 167 of the institution's series, have been issued during the year. The first of these is devoted to "The Composition of the Atmosphere with Special Reference to its Oxygen Content," and proves the remarkable fact of the essential constancy of this element in the atmosphere.

Department of Terrestrial Magnetism

Highly effective progress has been made by this department during the past year in its magnetic survey of the globe. By means of the non-magnetic ship *Carnegie* it is now easier to make a magnetic survey of the ocean areas than of the land areas, for the former are now more readily accessible than the latter. At the end of the preceding fiscal year the *Carnegie* was at Batavia, Java. On November 21, 1911, she set sail for an additional circuit of the Indian Ocean, whence she proceeded to Manila, Philippine Islands, where she arrived February 3, 1912. From Manila she proceeded to Suva, thence to Tahiti, and is now en route to Coronel, Chili. During the fiscal year she traversed about 28,000

miles. Her courses are arranged to intersect as frequently as possible her own previous tracks, those of the *Galilee* and those of previous expeditions on which magnetic elements were observed. Valuable checks on the determinations of these elements are thus secured, and in case of considerable intervals between the dates of different determinations, data for secular variation of the magnetic elements are also obtained. As related in the report of a year ago, unexpectedly large errors were found in the best magnetic charts of the Indian Ocean and for some parts of the Pacific Ocean. In order that corrections may be speedily applied to such charts the results of the cruises of the *Carnegie* are promptly made known to the principal hydrographic offices of the world. It is expected that the *Carnegie* will complete her present circumnavigation of the world near the end of the next fiscal year.

Observations have been continued simultaneously on land areas, embracing portions of five continents and about twenty different countries. Many noteworthy series of transcontinental stations have now been completed. Of these, one extending across the entire continent of South America, beginning at Para, at the mouth of the Amazon, and extending to Callao on the Pacific coast, by way of the Amazon and Ucayali rivers and Lima, has been finished during the past year.

The first volume of researches of the department, giving the results of land observations from the time of its establishment in 1905 down to the end of the year 1910, is now in press. The final computations of the ocean observations made during the various cruises of the *Galilee* and the *Carnegie* are also well advanced for a second volume. Many improvements in instrumental appliances have been made during the year in response to needs and suggestions arising from the extensive experience of the department on land and sea. One of the most important of the new appliances devised is that called an "earth inductor," which permits the measurement of the dip of the magnetic needle with increased precision and decreased labor over devices previously used. An attempt is now being made to apply this apparatus, which has proved completely successful on land, to the determination of dips on the *Carnegie*.

Solar Observatory

The past year has been one of minimum sun-spot activity; but effective progress has been made in many other branches of solar and stellar research undertaken by the observatory. The wide range of this work may be indicated by the fact that the results of the investigations of the year are summarized by the director under thirty-five different heads. The new tower telescope has been completed and important auxiliary apparatus has been added to the equipment of the 60-inch reflector. A fireproof office building, which will afford adequate quarters for the staff and safety for the original records and photographic plates of the observatory, has been constructed and made ready for occupancy during the year.

The 150-foot tower telescope with its spectrograph and spectroheliograph has been tested and found to be quite up to expectations. The 60-inch reflector has proved increasingly effective in the wide variety of work undertaken with it. Between forty and fifty new spectroscopic double stars have been found; and amongst the many stars whose radial velocities have been measured is one which surpasses all other hitherto observed, its velocity being about 150 miles per second.

Two eminent research associates, namely,

Professor Kapteyn, of Groningen, and Professor Störmer, of Christiania, have taken part in the work of the observatory during the year. Professor Kapteyn, who has served in this capacity for several years previously, has been of great service to the department, especially in the planning of a program of work with the 60-inch reflector, so that it may yield a maximum return alike for problems of stellar distribution and stellar development. Professor Störmer, who is one of the highest authorities concerning auroras, has sought to determine especially the connection of these phenomena with the sun. Of their connection with the sun and with the earth's magnetism there is little doubt, and the recent demonstration of the atomicity of matter in general and the atomic nature of electricity in particular may be confidently expected to lead to distinct advances in our knowledge of these phenomena in the near future.

The laborious task of shaping and testing the glass disk for the proposed 100-inch telescope has proved a disappointment in showing that this disk, which was accepted provisionally from the makers several years ago, will not answer the requirements. At this writing it appears possible that some expedients may be adopted to overcome the instability of this disk; but the probability that it may be made to work satisfactorily is small. In the meantime the makers of such large disks have not succeeded in making one of sufficient uniformity in density. In view of these difficulties the director is disposed to try a thinner disk if one can be found possessing the requisite degree of homogeneity. Thus this project must suffer further delay, although it is practically certain that the difficulties presented may be ultimately overcome.

Investigations of Research Associates and Collaborators

The relations of research associates and collaborators of the institution are so diversified and complex that they are difficult to specify at any given epoch. Individuals who have received direct aid during the year to their investigations through grants are mentioned in the preceding financial section of this report. Those who have received indirect aid through grants made for the publication of their researches are also mentioned in the section just referred to. Many collaborators and assistants have received compensation directly from research associates in charge of investigations, while some research associates and many collaborators have received no direct compensation. It appears to be neither desirable nor practicable at present to seek any higher degree of correlation of this work, since it is carried on by many individuals in many different parts of the world. The best evidences of the quantity and quality of the results accomplished are to be found in the publications listed in part in a subsequent section of this report and more at length in the general bibliography of the year published in the current year book. The work of the year has extended to an aggregate of more than twenty different fields of research and has occupied the attention of more than a hundred investigators. Many of these have rendered special reports to be published in the year book, while reference is made to the work of many others in the reports of the larger departments of research.

FINANCIAL STATEMENT FOR FISCAL YEAR 1911–12

The sources of funds available for expenditure during the past fiscal year, the allotments for the year, the revertments made during the year, and the balances

Object of Appropriation	Balances Unallotted or Unexpended Oct. 31, 1911	Appropriation, Dec. 15, 1911	Revertments Oct. 31, 1911, to Oct. 31, 1912	Total	Aggregates of Allotments and Amounts Expended and Transferred	Balances Unallotted or Unexpended Oct. 31, 1912
Large grants	....	$641,100	$8,122.06	$649,222.06	$649,222.06	....
Minor grants	$5,000.00	172,400	1,000.00	178,400.00	172,186.51	$6,213.49
Publications	15,324.33	60,000	4,465.78	79,790.11	62,908.93	16,881.18
Administration	20,561.22[2]	50,000	3,137.60	73,698.82	53,791.13	19,907.69[2]
Reserve fund	....	250,000	....	250,000.00	250,000.00	....
Insurance fund	....	23,000	....	23,000.00	23,000.00	....
Total	40,885.55	1,196,500	17,725.44	1,254,110.99	1,211,108.63	43,002.36

unallotted and unexpended at the end of the year are shown in detail in the above statement.

The following list shows the departments of investigation to which the larger grants were made by the trustees at their last annual meeting and the amounts allotted from these grants by the executive committee during the year:

Department of Botanical Research	$37,905.00
Department of Economics and Sociology	12,500.00
Department of Experimental Evolution	37,477.00
Geophysical Laboratory	75,000.00
Department of Historical Research	26,600.00
Department of Marine Biology	18,000.00
Department of Meridian Astrometry	26,316.00
Nutrition Laboratory	48,539.06
Division of Publication	10,000.00
Solar Observatory	254,075.00
Department of Terrestrial Magnetism	97,810.00
	$644,222.06
Transferred from Nutrition Laboratory to unappropriated fund	5,000.00
	$649,222.06

The fields of investigation to which minor grants were assigned, the names of the grantees and the amounts of the grants are shown in the following list:

DETAILS OF MINOR GRANTS

Field of Investigation	Names of Grantees	Amount of Grants
Astronomy	Gale, Henry G.	$1,000.00
	Kapteyn, J. C.	2,000.00
	Störmer, Carl	1,800.00
Archæology	Bandelier, Adolf F.	2,000.00
	Frothington, A. L.	750.00
	Van Deman, Esther B.	1,200.00
Bibliography	Index Medicus	$12,500.00
Biology	Riddle, Oscar	4,400.00
Botany	Britton, N. L., and Rose, J. N.	3,400.00
	Rose, J. N.	3,600.00
	Fitting, Hans	1,800.00
Chemistry	Acree, S. F.	2,000.00
	Baxter, G. P.	1,000.00
	Osborne, T. B., and Mendel, L. B.	15,000.00
	Jones, H. C.	2,200.00
	Morse, H. N.	4,000.00
	Noyes, A. A.	3,000.00
	Richards, T. W.	3,000.00
	Sherman, H. C.	1,200.00
Climatology	Huntington, Ellsworth	4,000.00
Exp. Evol.	Dept. of Exp. Evolution	851.75
Geology	Chamberlin, T. C.	4,000.00
	Moulton, F. R.	2,000.00
History	Dept. of Hist. Research	3,000.00
	Osgood, H. L.	500.00
Literature	Bergen, Henry	1,800.00
	Sommer, H. Oskar	2,000.00
Marine Biology	Watson, John B.	500.00
Mathematics	Dickson, L. E.	500.00
	Morley, Frank	1,200.00
Metallurgy	Howe, Henry M.	500.00
Meteorology	Bjerknes, V.	1,800.00
Paleontology	Case, E. C.	2,000.00
	Hay, O. P.	3,000.00
	Wieland, G. R.	3,000.00
Paleography	Loew, Elias A.	1,500.00
Physics	Barus, Carl	500.00
	Hayford, J. F.	2,000.00
	Nichols, E. L.	3,000.00
Physiology	Cooke, Elizabeth	500.00
	Reichert, E. T.	1,500.00
Terrestrial Mag.	Dept. of Ter. Mag.	3,600.00
Zoology	Castle, W. E.	2,500.00
	Naples Zool. Station	1,000.00
Adm. Building (additions)	....	6,462.70
		199,064.45
Transferred: Large grants	....	3,122.06
Unappropriated fund	....	50,000.00
		172,186.51

[2] Unexpended amount.

THE ADMINISTRATION OF THE FUR SEAL SERVICE

THE report of the House Committee on Expenditures in the Department of Commerce and Labor, on the administration of the fur seal service, has been made public as House Report, No. 1425, 62d Cong., 3d Ses. It contains a majority report, signed by Representatives Rothermel (chairman), McDermott, Young and McGillicuddy; a statement of "views of the minority," and the minority report, signed by Representatives McGuire, Madden and Patton.

This committee, in the course of its investigation, held numerous hearings extending from May 31, 1911, to July 31, 1912. The testimony heard comprises 1,013 pages, with an appendix of correspondence and documents numbering 1,232 pages. The majority report is divided into 7 counts, five of which have to do with certain alleged harmful or unlawful acts of the two leasing companies which we need not now go into. They are ancient history, since the fur seal herd is now, and has been since 1910, in sole charge of the government.

The sixth item in the report deals with the period of government control, and states that "in spite of the express prohibition of the law, it is disclosed in the testimony that yearling and female seals have been killed by the agents of the government in charge of the seal islands." One looks in vain in the testimony for any such evidence. On the other hand, the testimony clearly shows that of the 13,500 skins taken in 1910 (of which 12,920 were sold in London in December of that year), the season under particular consideration, only 90 were under the standard weight of the two-year-old, as shown by the green weights taken by the agents on the islands, and only 92, by the salted weights of the London fur dealers. With these possible exceptions, no yearling animals were killed; and in the period from 1904 to 1911, in which the individual weights of over 90,000 skins were taken, only 700 skins were underweight. These exceptions may represent accidents or mistakes in judgment, it being necessary for the clubber to judge the weight of the skin while the animal is alive. It was, furthermore, not against the law to kill yearlings; the prohibition in this case was by departmental regulation. The charge that females were killed depended upon the alleged commingling of the sexes in the yearling class. It is not a fact that the yearling males and females commingle on land, but this is not necessary to disprove the charge, as yearlings are shown not to have been killed, except in the few exceptional cases above noted.

The charge of killing yearlings was in itself a most insignificant one. Representative Townsend, whose resolution brought on the investigation, asserted in his opening address that 30,000 such animals had been killed. Mr. Henry W. Elliott, the complaining witness, placed the number at 128,000. The total number of animals killed by the North American Commercial Company during its twenty-year period scarcely exceeded 300,000. It may be noted that other testimony, by Mr. Alfred Fraser, showed that in this very same period more than a million seals had been killed at sea, of which we know from other sources fully 80 per cent. were gravid or nursing females. This fact together with all other facts relating to the effect of pelagic sealing upon the fur seal herd is ignored in the majority report.

Item 7 of the majority statement recites how "the testimony taken before the committee was the basis in large measure of the action of Congress . . . which establishes a closed term of five years . . . to all commercial killing of seals." The testimony nowhere discloses any valid reason for the suspension of commercial sealing. On the contrary, the testimony contains the positive assertions of such authorities as Dr. D. S. Jordan, of Stanford University; Dr. L. Stejneger, of the Smithsonian Institution; Dr. C. H. Merriam, late of the U. S. Biological Survey; Dr. F. A. Lucas, of the American Museum of Natural History; Dr. C. H. Townsend, of the New York Aquarium, and others, all of whom have visited the fur seal islands in recent years and made studies of the animals, to the effect that such suspension is not only not necessary, but

is likely to prove highly detrimental to the welfare of the herd.

The majority report is summed up in a series of recommendations. The first four provide for confiscation of the bond of the North American Commercial Company, for suit for damages against the original president of that company, for rectification of a wrong against Russia in the matter of a seizure of a sealing vessel—all matters foreign to the interests of the herd. The fifth recommendation only is pertinent and this we may give in full. It is as follows:

(5) That in view of the closed season of five years provided by act of Congress, of August 15, 1912, the services of the Treasury agents on the said Pribilof Islands can be dispensed with, resulting thereby in a saving to the Federal Government of approximately $25,000 annually.

Presumably the act of Congress refers to the Sulzer bill which is actually of the date of August 25. There have been no treasury agents on the Pribilof Islands since 1903, when the islands were transferred to the Department of Commerce and Labor. But these are matters of detail. The important thing is that the government force on the islands is to be disbanded. These men have charge of 300 natives who must be governed, fed and clothed. The law still permits the killing of a few animals for natives' food. Their skins must be cared for. The blue foxes must be cared for and fed. There is a reindeer herd on each island. The rookeries are in need of betterment work, especially in the eradication of areas infested with the hookworm, destructive of the young pups. The recommendation of Mr. Rothermel and his colleagues would abandon the islands and their inhabitants to their own devices for five years. When left without restraint it is well known that the natives are unable to resist the temptation to kill pup seals for food. That they would kill thousands of young seals for that purpose, should the agents be absent, is certain. Are Mr. Rothermel and the three who united with him in this recommendation willing to assume the responsibility for this waste which is quite sure to take place if their advice be accepted by congress? In return the government would effect a saving of $54,750. (The salaries total only $10,950 annually instead of $25,000 as stated in the Rothermel report.) The suspension of land sealing which has paved the way for this magnificent stroke of economy involves the wasting of at least 63,000 superfluous males which at the age of three years would give skins worth $40 each, a cash loss of $2,500,000, to say nothing of the damage these animals will occasion to the mother seals and their helpless young by their fighting.

It is hard to see how this recommendation came to be written. Some explanation is deducible from a significant paragraph in the minority statement which follows:

Although the committee took more than 1,000 pages of testimony, and the last hearing was six months ago, on July 31, 1912, the committee has never held a single meeting for the purpose of considering the evidence, and the report made by the chairman was never submitted to the committee for its consideration; no meeting of the committee was ever held for this purpose, and we are not satisfied that it has been approved by a majority of the committee.

This interesting commentary is followed by further equally interesting comment, and then comes the minority report itself. This is an able document and treats the investigation from the only rational standpoint, the welfare of the herd. The charges are stated in detail. The natural history points necessary to an understanding of the problems are accurately set forth. The methods of land sealing and of pelagic sealing are discussed, with their effect on the herd. The charges are then specifically treated in the light of the testimony and found to be without support. The minority's conclusions are expressed in the following words:

We are convinced that the sole important cause of the decrease of the fur-seal herd during the last decade has been pelagic sealing, and that land killing, as practised on the Pribilof Islands during that time, has had nothing to do with the diminution of the herd.

After a careful examination and consideration of all the evidence, we find that the administration of the fur-seal service by the Department of Com-

merce and Labor and by the Bureau of Fisheries of that department has been in accordance with the law; that the regulations issued from time to time by the department and the instructions issued to the agents have been properly observed; that the fur-seal herd has been handled intelligently; and that the charges have not been sustained.

The charges of malfeasance brought with such a flourish against the Department of Commerce and Labor by Mr. Henry W. Elliott, with the support of Dr. William T. Hornaday and a very small minority of the Camp Fire Club, whom the majority report characterizes as "public spirited citizens," have proved a fiasco. It is said that they influenced the action of congress in suspending land sealing. We can well believe this. The aforesaid congressional action provides for the throwing away of $2,500,000 worth of sealskins, jeopardizes the permanence of a beneficent treaty which is essential to the only salvation of the herd, and inflicts upon the rookeries a horde of idle fighting bulls to work destruction among the breeding females and their young. There is a close resemblance between this ill-advised action of congress and the equally unwarranted investigation, as disclosed in the dual report of the committee conducting it.

If congress had wished to enact a law *for the encouragement of pelagic sealing* it could scarcely have done so more effectively than it did when it prohibited commercial killing on the land of the surplus male seals.

GEORGE ARCHIBALD CLARK

STANFORD UNIVERSITY, CAL.,
February 11, 1913

THE ALPINE LABORATORY

THE Alpine Laboratory is situated at 8,500 feet on the Cog Railway between Manitou and the summit of Pikes Peak. The flora is both rich and varied, and in connection with the remarkable diversity of habitat found in this rugged mountain region offers exceptional opportunities for the study of plant response, and the origin of new forms. Among the alpine summits of the continent, Pikes Peak is unique in the series of great formational zones which lies across its face. From the Great Plains grasslands, the series runs from valley woodland at 5,800 feet to mesa, chaparral, foothill woodland, pine forest, aspen woodland and spruce forest to alpine meadow, rock field and bog at 11,000–14,000 feet in a distance of 7 miles. From the very nature of the mountains, weathering, erosion and other physiographic factors bring about the almost countless repetition of the same or similar habitats, and produce numbers of primary and secondary successions illustrating a wide range of developmental processes and principles.

Ecological work was first done at Pikes Peak in 1899, and has been carried on each summer since that time. In consequence, it is probable that no other area has been so intensively studied by means of instrument and quadrat, and offers such a fascinating array of ecological problems for which the foundation has at least been sketched. The scope and nature of this foundation work is indicated by the following publications: "Development and Structure of Vegetation, 1904"; "Research Methods in Ecology, 1905"; "Relation of Leaf Structure to Physical Factors, 1905"; "Vegetation of the Mesa Region, 1906"; "Life History of the Lodgepole Burn Forests, 1909"; "Natural Vegetation as an Indicator, 1910"; "Wilting Coefficient, 1911," and "Development and Structure of Sandhill Vegetation, 1913."

The practical aspects of quantitative ecology are represented by the Fremont Forest Experiment Station, and the Dry-land Agriculture Field Station of the U. S. Department of Agriculture, perhaps the best equipped stations in the world for the exact study of vegetational problems.

The field of investigation open falls into four general divisions: (1) the use of quantitative methods of studying habitat and plant; (2) the application of ecological methods and principles to forestry, agriculture and plant pathology; (3) the measured study of individual response to the habitat with especial reference to the origin of species; (4) quadrat study of the development and structure of plant formations. The oppor-

tunity for applying the exact methods of modern ecology to the problems of Silvics, Forest Pathology, Dry-land Agriculture, Plant Breeding and Experimental Evolution is unsurpassed. Opportunity will also be offered for the taxonomic study of the varied flora.

While the plan contemplates graduate work primarily, advanced students in botany or related subjects, such as forestry and agronomy, will be accepted, provided they have had sufficient training to enable them to work on individual problems under adequate supervision. It is hoped that the opportunity will be especially welcome to foresters, pathologists, agronomers and teachers of botany who have not yet become acquainted with the methods and outlook of exact ecology, and its many applications to practical plant science. The summer's work will be accepted as the full equivalent of a semester's work for the master's or the doctor's degree at the University of Minnesota, and the University of Nebraska. It is expected that other universities will permit similar arrangements.

FREDERICK E. CLEMENTS
THE UNIVERSITY OF MINNESOTA

SCIENTIFIC NOTES AND NEWS

DR. FELIX KLEIN, professor of mathematics at Göttingen, is about to retire from active service.

MRS. A. R. WALLACE writes to an American correspondent: "Dr. Wallace is very well and busy, writing as hard as ever; he has just passed 90, and feels like 50."

DR. JAMES M. TAYLOR will retire from the presidency of Vassar College at the close of the present year.

DR. ALEXIS CARREL, of the Rockefeller Institute for Medical Research,. has been appointed a knight of the Legion of Honor by the French government.

DR. F. W. PUTNAM, professor emeritus of anthropology at Harvard University, has been elected non-resident vice-president of the Washington Academy of Sciences.

PROFESSOR S. W. WILLISTON, of the University of Chicago, will attend the ninth International Congress of Zoology as the delegate at large of the American Zoological Society.

THE Lalande Prize, of the Paris Academy, has been awarded to Professors H. Kobold and W. Wirtz for their work on the determination of the motions of nebulæ.

THE Bessemer gold medal of the Iron and Steel Institute will be awarded to Mr. Adolphe Greiner, general director of the Société Cockerill, Seraing, at the annual meeting to be held in London on May 1 and 2.

AT the last meeting of the Royal Australasian Ornithologists' Union of Melbourne, Australia, Dr. R. W. Shufeldt, of Washington, D. C., was elected an honorary member.

Two bronze horses, made by George Ford Morris, the New York animal artist, illustrating the points of an ideal draft horse, and the deficiencies of an inferior horse, have been presented to Dr. A. S. Alexander, of the University of Wisconsin, in recognition of his work in developing the horse breeding industry, both of Wisconsin and the country at large.

DR. EDWARD A. BURT, professor of natural history (botany) in Middlebury College, Middlebury, Vt., has been appointed librarian and mycologist of the Missouri Botanical Garden, St. Louis, Mo. He will leave Middlebury at the close of the present college year and begin his work at the Missouri Botanical Garden in September.

AT the recent annual meeting of the board of managers of the Wistar Institute of Anatomy and Biology, Dr. Helen Dean King was elected assistant professor of embryology. Dr. King will continue the embryological work of the institute which was begun two years ago by Professor G. Carl Huber, who has returned to the University of Michigan.

DR. ROBERT H. LOWIE, of the department of anthropology of the American Museum of Natural History, has been promoted to the rank of associate curator.

MR. WILLIAM ROBERT OGILVIE GRANT has been promoted to be assistant keeper of the department of zoology at the Natural History

Museum, South Kensington, in succession to Mr. Edgar Smith, who will retire, by reason of age, on March 31.

Dr. William McPherson, professor of chemistry and dean of the Graduate School at the Ohio State University, has been granted a leave of absence for the second semester. He will spend the semester in Germany.

Dr. Bryant Walker, of Detroit, Michigan, will bear the expense of a zoological expedition to Colombia, South America, in the summer of 1913. The field party will consist of the head curator of the museum, Dr. A. G. Ruthven, Professor A. S. Pearse, University of Wisconsin, honorary curator of crustacea, and Mr. Frederick Gaige, of the department of zoology, University of Michigan. The work will be carried on in the Santa Marta Mountains, and will consist principally of detailed studies of the local distribution of the crustaceans, molluscs, ants, amphibians and reptiles, although an attempt will be made to get specimens of other groups needed in the museum.

Professor Harris Hawthorne Wilder, of the department of zoology at Smith College, and Mrs. Wilder, instructor in zoology, have been given leave of absence for the second half year, and will proceed to Naples.

Professor James Hayden Tufts, head of the department of philosophy in the University of Chicago, will be the convocation orator at the eighty-sixth convocation of that institution on March 18, the subject of his address being "The University and the Advance of Justice."

Professor Ludwig Aschoff will deliver the Cartwright lectures of the Association of the Alumni of the College of Physicians and Surgeons, Columbia University. There will be two lectures, the subjects being "Thrombosis" and "Contracted Kidney," and they will be given at the New York Academy of Medicine on March 12 and March 15.

Professor Ludwig Sinzheimer, of the University of Munich, has arrived in Madison, where he will give a course of lectures in the University of Wisconsin during the second semester. His subjects are "Industrial Labor Problems" and "Methods of Social Reform."

Mr. John M. Goodell, Assoc.Am.Soc.C.E., consulting engineer, *Engineering Record*, New York City, on February 20 delivered a lecture on "Essentials of Technical Writing," before the graduate students in highway engineering at Columbia University.

By invitation of the scientific faculty, Professor George Grant MacCurdy, of Yale University, gave a public lecture at Dartmouth College on the evening of February 10, his subject being the "Antiquity of Man."

Harlan I. Smith, of the Geological Survey of Canada, delivered an illustrated public lecture on January 28 in the Normal School, Ottawa, on "Modern Museum Work for the Scientist, the Teacher and the Public" under the auspices of the Ottawa Field Naturalists' Club.

Dr. Rollin A. Harris, of the U. S. Coast and Geodetic Survey, lectured before the Sigma Xi Society of Cornell University on February 10. His subject was "The Leading Characteristics of the Tides."

With the support of the Christiania and Leipzig Academies, the firm of B. G. Teubner contemplates the publication by subscription of the collected works of Sophus Lie, edited by Friedrich Engel.

The *American Museum Journal* states that by the death of the artist, Louis Akin, at Flagstaff, Arizona, on January 2, the museum's plans for mural decorations for the Southwest Indian hall have received a check. Mr. Akin had been commissioned to prepare tentative sketches for sixteen panels and had made a number of preliminary figure studies with that end in view. He expected to have finished the sketches during the present year. It is hoped that it may be possible to exhibit Mr. Akin's studies during the spring months when there is proposed a special exhibit of material and paintings illustrating the life of the Indians of the Pueblo region. Mr. Akin is best known to the world by his paintings of

Hopi Indians. His work is a faithful portrayal of the tribe, with which he lived during the years of his study and of which he was made a member.

We learn from *Nature* that the friends of the late Mr. H. O. Jones, F.R.S., who with his wife met his death last summer in the Alps, are of opinion that some permanent memorial to him should be established in the University of Cambridge. There is at present no teaching post especially associated with physical chemistry in the university, and as the laboratory now affords opportunity for study and research in this modern branch of chemistry, the committee appointed for the purpose of the memorial recommends that the endowment of such a post in connection with physical chemistry would form an appropriate and a lasting memorial to Mr. Jones, and one calculated to further a cause in which he was peculiarly interested. Subscriptions to the extent of more than £2,750 have already been received.

Dr. Samuel Allen Lattimore, professor of chemistry at the University of Rochester for more than forty years until his retirement as professor emeritus in 1908, died on February 17, aged eighty-four years. Professor Lattimore was a vice-president of the American Association for the Advancement of Science in 1880.

Dr. J. E. Manchester, instructor in mathematics at the University of Minnesota, and previously president of Vincennes University, died on January 24, aged fifty-seven years.

G. Harold Drew, B.A., of Christ's College, Cambridge, and research associate of the Department of Marine Biology of the Carnegie Institution of Washington, died on January 29.

There will be a civil service examination on April 9, for the position of miscellaneous computer in the Naval Observatory.

There will be New York state civil service examinations on March 22 for the position of chief medical officer, port of New York, at a salary of $2,500, and locomotive boiler inspector in the second district, at a salary of $3,000.

A report has been received at the American Museum of Natural History from the South Georgia Islands expedition under Mr. Robert C. Murphy, which reached the Bay of Islands, November 27, and was waiting for the sea elephant season to open in order to obtain the desired specimens for a museum group of this Antarctic species. Mr. Murphy's statement that there were already on the ground twenty-one steamers representing seven commercial companies, mainly Norwegian, is discouraging for the future of the southern sea elephant race even with the close season set upon the species by the English. The South Georgia Islands expedition, made possible through the liberality of Mr. Arthur Curtiss James, hopes to obtain young penguins needed for completion of a penguin group under construction at the American Museum, in addition to sea elephants and a general collection of birds.

At the stated meeting of the College of Physicians, Philadelphia, held on February 5, an Assyrian medical tablet, dating from the seventh century B.C., the gift of Drs. S. Weir Mitchell and Richard H. Harte, was presented by Dr. F. P. Henry.

The mental hygiene exhibit prepared for the International Congress of Hygiene and Demography will be held in Philadelphia, March 13–22. The exhibit consists of charts, statistics, photographs and models showing past and present methods of care for the insane.

The Stanford University Medical Department announces the thirty-first course of popular medical lectures to be given as follows:

February 7—"Eugenics," President David Starr Jordan.

February 21—"The State and the Physician," Professor J. G. Fitzgerald, University of California.

March 7—"Grafts and Transplantations of Human Tissue," Dr. Leo Eloesser.

March 21—"The Work of the Medical Department of the U. S. Army on the Firing Line"

(illustrated), Captain James L. Bevans, Medical Corps, U. S. Army.

April 4—"Some Skin Diseases We Need not Have" (illustrated), Dr. H. E. Alderson.

April 18—"The Work and the Aims of Our Health Department" (illustrated), Dr. R. G. Brodrick, Health Officer of San Francisco.

THE provision of satisfactory municipal and domestic water supplies constitutes one of the most important problems that is presented to our cities and towns. The municipalities that are situated within easy reach of upland country can as a rule obtain pure water from the uninhabited highland drainage areas. Those located in the flatter portions of the country must depend on the local rivers or on underground sources. With increase in population the rivers inevitably become so polluted that it is necessary to purify the water before it can be devoted to domestic use. Such conditions prevail in the prairie region along the Ohio Valley and especially in the states of Ohio, Indiana and Illinois. Most of the larger cities in this region resort to purification of polluted river water. Cincinnati, Columbus, Indianapolis, Louisville and many smaller cities maintain filtration systems. For small cities and towns it is frequently possible to procure underground water supplies that will be sufficiently constant to warrant development. Some years ago the United States Geological Survey started investigations of ground-water supplies in the Ohio Valley. As a result two reports have already been published. The survey now announces the publication of a third, entitled "The Underground Waters of Southwestern Ohio," by M. L. Fuller, F. G. Clapp and R. B. Dole. The area covered by this report comprises about 5,600 square miles, or about one seventh of the state. The region receives abundant rainfall, but the streams are rather far apart and the springs are few and of small volume. This portion of Ohio is densely populated, the average population being about 150 to the square mile in the area as a whole and 50 in the rural districts, and as it contains many paper mills, distilleries and other manufacturing establishments the river waters are in many places badly polluted by sewage and industrial wastes, which render them unfit for drinking. For this reason carefully protected ground-water supplies are highly desirable for domestic purposes, especially in the cities and crowded villages, where the nearness of houses, barns and cesspools may make wells unsafe sources of drinking water. In this portion of Ohio immense quantities of water are also required in the industries, and as the waters of the streams are generally too muddy and too uncertain in quantity for this purpose, wells are largely used, and the need of more specific information concerning ground-water supplies is urgent. Limestones predominate in this region, extending in some places to depths of hundreds of feet, and the lack of sandy water-bearing beds makes the ground-water problem especially difficult. Fortunately, however, the surface is covered with a sheet of unconsolidated pebbly clay, underlain locally by some sand and gravel, and nearly all the larger valleys are deeply filled with sand, gravel or unconsolidated glacial material. These deposits contain much underground water, largely of local origin. Many of the wells on low ground, both those in rock and those in the alluvial fillings of the valley, yield flowing water, and nearly everywhere the water is under artesian pressure, rising very materially when encountered. In general, deep wells give no promise in this region, for, though water can be obtained from such wells in most places, it will generally be either salty or highly charged with sulphur.

UNIVERSITY AND EDUCATIONAL NEWS

GIFTS aggregating more than $1,000,000 to Washington and Lee University, Lexington, Va., are provided for in the will of Robert P. Doremus, member of a New York Stock Exchange firm, who died on February 1 last. Mr. Doremus was a graduate of Washington and Lee University.

AN increase of $12,800 in the annual state appropriation for Middlebury College has been made by the legislature of Vermont.

Miss Emily Southmayd, of New York City, has presented Yale University with \$125,000 to found a chair of equity jurisprudence in the Yale Law School in memory of her brother, the late Charles F. Southmayd.

The American Telegraph and Telephone Company has given the Massachusetts Institute of Technology \$5,000 a year for five years to catalogue and maintain the electrical library recently given to the institution. It is also reported that the American Telegraph and Telephone Company will support research work in electricity at the institute.

Mr. G. A. Wills and Mr. H. H. Wills have given £150,000 for the extension of the buildings of Bristol University, in memory of their father, who was the first chancellor. Their brother, Mr. W. M. Wills, has offered £20,000 for the general endowment fund of the university.

In the *President's Report*, issued this month by the University of Chicago Press, President Harry Pratt Judson says: "It is of course well understood as a distinct policy of some educational institutions to spend what is necessary regardless of resources, depending upon alumni and friends of the institution to provide the resulting deficit. It is not the belief of the University of Chicago that deficit financing is safe from any point of view." The report shows that there was a surplus for last year of \$17,270.29. It also shows that about forty-three per cent. of the total income of the university for the year was derived from students, that the sum of \$107,441.14 was returned to them in the form of fellowships and scholarships, and that fifty-six per cent. of the total expenditures was paid for instruction. During the year the sum of \$1,087,178.92 was paid in in the form of gifts. The total gifts paid in from the founding of the university to June 30, 1912, amounts to \$33,784,523.81.

At Yale University Dr. William Ernest Hocking has been promoted to be professor of philosophy, and Dr. Frederick Rogers Fairchild to be professor of political economy.

DISCUSSION AND CORRESPONDENCE

THE MEMORIAL TO ANTON DOHRN

In the issue of Science for November 10, 1911, was printed a statement concerning the memorial to Anton Dohrn, with an appeal from the executive committee of the American subcommittee for subscriptions to a fund to be established for this purpose. The subscription is to be closed May 1, 1913, and it is hoped that additional contributions may be received before that date. The American subscription is still far short of what the committee had hoped for, and should be increased if this country is to be creditably represented in the general fund. Checks should be drawn to the order of the Anton Dohrn Memorial and sent to Mr. Isaac N. Seligman, care of J. and W. Seligman and Co., No. 1 William St., New York City.

Edmund B. Wilson,
Chairman of the American Subcommittee

Columbia University,
New York, N. Y.

A SUGGESTED FORMULA FOR BIOLOGISTS

It is a well known fact of observation that the smaller creatures are ever the more vigorous. A flea is proportionately vastly more powerful than a cat; and the cat than an elephant. While in paleontology giantism is, I think, recognized as a stigma of degeneracy, preceding racial extinction.

Now, may not these observations be embodied in the following single mathematical form.

The weight of any two similar animals is plainly proportionate to the *cube* of their heights. While their muscular power may surely be taken as proportionate to the area of the similar cross sections of corresponding muscles; and thus proportionate to the *square* of their heights. So that, of 2 cats say, if B be n times higher than A, then it is n^3 times heavier; but has only n^2 times more muscular strength. And is thus really $1/n$ proportionally weaker. For, plainly, during any corresponding exertion, it must move n^3 more weight, with but n^2 more strength.

Alan S. Hawkesworth

SCIENTIFIC BOOKS

The Mechanistic Conception of Life. By Professor JACQUES LOEB. University of Chicago Press. 1912. Pp. 232.

The title and the contents of this volume convey very different impressions to the reader. The title leads one to expect that in the volume one will find a demonstration that vital phenomena are mechanistic, or an exposition of the organism as a mechanism, or some discussion of the points at issue between the mechanist in biology and his opponent, the vitalist. But, on reading the book, this expectation is not realized. Instead one finds, as the preface states, that the volume consists only of "essays—written on different occasions mostly in response to requests for a popular presentation of the results of the author's investigations." Indeed, it is further quite frankly acknowledged, that "the title of the volume characterizes the general tendency of these investigations as an attempt to analyze life from a purely physical-chemical viewpoint." The papers which make up the volume deal primarily and almost exclusively with the following subjects: The Activation of the Egg and Heredity, Tropisms, the Comparative Physiology of the Nervous System, Pattern Adaptation in Fishes, Physiological Morphology, Fertilization, Artificial Parthenogenesis, The Prevention of the Death of the Egg, and the Experimental Study of the Influence of the Environment on Animals.

Of the actual contents so far as they correspond to what is indicated by the statements of the preface a reviewer need make no criticism. Suffice it to say in description of them, that they consist for the most part of the narration and interpretation of various experiments in application of physical chemistry to certain isolated cases of vital phenomena. In the employment of this method Professor Loeb has been, as is well known, a pioneer, and no one can gainsay the importance of his discoveries. They form one of the most dramatic chapters in the history of biology. Indeed one can but recognize the brilliancy of Professor Loeb's hypotheses and experiments in attacking specific problems, and be grateful for the stimulus which his viewpoint and resulting methods have given to biological research. In general, one can only praise *any* new experimental method which brings results, and one can not repudiate by mere argumentation the facts which such a method reveals. Thus it would be only by repeating Professor Loeb's experiments and finding that they do not give the results which are claimed for them, or by throwing doubt upon them by cognate experiments, that one could put himself in a position justifiably to dispute or criticize the experimental data which are presented in the volume under review. Accordingly, since the greater part of Professor Loeb's book deals with specific methods and results of the kind just indicated, it is left for a reviewer to make only a few comments and general criticisms. However, by way of fulfilling this function, it would seem pertinent to raise the question, especially *à propos* of the title of the book, why Professor Loeb should have selected these particular essays to place under the caption of The Mechanistic Conception of Life, when he has so many others that would have served the purpose equally well. Further, it may be remarked concerning the papers selected and now called "Essays," that there is not discoverable, either in their arrangement or in the data which they present, any system which converges to that which both the title and certain emphasized statements of the volume would indicate to be its chief purpose and claim, namely, the demonstration of the applicability, in some specific sense, of the mechanistic conception *to all life and to all that life manifests.* One can make this criticism, and yet admire the brilliancy and fruitfulness of Professor Loeb's experiments. One can indeed thus criticize, and yet be convinced that in *some sense* the mechanistic conception of life is the correct one, and certainly that it is a very fruitful one in stimulating such experiments as Professor Loeb's. But one can hold this conviction, and still find good reasons for maintaining that *such* experiments, consisting for the most part of the application

of physical chemistry to a relatively few vital phenomena, do not prove that *life and all its manifestations* are mechanistic in any but the most general sense of this term, if, indeed, in this way. While a reviewer, then, may not, perhaps, be in a position to take issue with Professor Loeb's specific experiments and results, he may be permitted to make a few comments concerning the method which conceivably might lead to the establishment of Professor Loeb's broad generalizations, or, at least, would clarify them.

It would certainly seem, if one wished to demonstrate that life is, or is not, mechanistic in any exact sense, that one should, for example, state with precision that meaning of this term which is commonly accepted by authorities on mechanics. The term thus defined is, that mechanics is the science of masses moving, and acted upon by forces, in accordance with Newton's laws and the principles of d'Alembert, of Hamilton and of Lagrange. Having thus defined the term either in this or in some other precise way, one could then ascertain whether the organism has such characteristics as warrant putting it in its entirety, or in part, under the conception of mechanism. But Professor Loeb nowhere pursues this method. For his broad generalization, his only real argument, stripped of its rhetorical clothing, is, that, since certain relatively isolated life phenomena can be experimented with by the methods of chemistry, physics and physical chemistry, and accounted for by the results of these sciences, *all life in all of its aspects* is mechanistic. However, it is clear that this conclusion in any precise sense follows, provided only that chemical, physical and chemical-physical phenomena are themselves mechanistic in some precise and technical sense of the term. But, whether they are this or not, and, if they are, to what extent, are themselves questions which are to-day undecided, or, at least, usually not made clear. Vital phenomena do undoubtedly involve chemical and physical processes, but these processes at the present time have themselves not been successfully treated by all the orthodox mechanistic principles. At best one finds physico-chemical phenomena treated only from the standpoint of the law of the conservation of energy and the second law of thermodynamics. However, the criticism which on this ground can be made against Professor Loeb is one that is by no means to be directed against him alone, but can be made a very general one. For the only argument that is usually found among biologists for the mechanistic conception is the one which he presents. In fact, with this the case, it must be said, that really all that most biologists mean by "mechanistic" is what Professor Loeb means, namely, that which is physical, chemical and physical-chemical, or, more precisely, simply that which is *determined or caused.* However, *there is a more exact scientific meaning* of the term in accordance with which it may fairly be asked, if physical and chemical phenomena are ever *wholly* and *exclusively* mechanistic. Put with precision, the question is, whether these phenomena are wholly and exclusively moving masses acted on by forces, as defined, described and explained by Newton's laws and the classical principles previously mentioned. Thus stated, the question suggests the broader and more important ones, scientifically and philosophically: Are *all* the things with which we are acquainted in this universe of ours mechanistic in this precise sense, and, if they are, what does this mean? Does it mean that *all* phenomena are *reducible* to masses in motion in the sense that they ultimately consist of nothing but these moving masses, or does it mean only that *all* phenomena are *compatible* with the laws of moving masses acted on by forces, but are nevertheless more than motion and masses, even as, for example, physical objects are numerical, but are more than the positive integers with which they are in one-one correspondence? These two concepts, "reducible to" and "compatible with," are radically different in their implications, and it is difficult to find either the biologist or the physicist who, holding to the universal applicability of the mechanistic conception, makes them clear. However, if one contends that something, say, the organism, is mech-

anistic, and interprets this to mean either "compatible with" (Loeb) or "reducible to" mechanism, then, in order merely to comply with the usual principles of *scientific* procedure, should he not determine with at least some precision the meaning of these terms? Otherwise, does not the claim, that the object under examination is mechanistic, have only the most general and indefinite meaning, such as "determined," etc.? Indeed, is not this meaning the only one that characterizes the position of most biologists, that life and life's phenomena are mechanistic? But is not "determined" itself a very general and indefinite concept, awaiting, for precision, the specification of particular causes?

As concerns method, then, the reviewer is of the opinion that neither the experiments described by Professor Loeb in this volume, nor, in fact, the whole list of results and experiments obtained up to the present time in application of physical chemistry to vital phenomena, scientifically justify the sweeping conclusion, either insinuated or made explicit, that life and all that life manifests in the field of conduct (ethics), science, religion and art, etc., are mechanistic in any precise sense. Such phenomena may be determined and caused. That few would deny. And they *may* also be mechanistic in some more precise and technical sense of the term. But until that sense is defined, and the meanings of such terms as "reducible to," "compatible with," and "explainable by" are specified with precision, so that it can be ascertained whether or not life and life's manifestations are of such specific character as in some one of these ways to be brought under mechanism, proof is lacking for what is otherwise only a vague conviction. However, in the present stage of the analysis of most phenomena manifested by living beings, both human and non-human, there does not seem to be discoverable sufficient evidence to show that they are reducible to, or explainable by mechanistic principles in any other than the most general sense. The successful application of physical chemistry to certain isolated biological phenomena must, of course, be admitted, and the position that all of life's manifestations may ultimately be also so *related* must be regarded as a perfectly permissible working hypothesis. But at the present time the position that mechanics, physics and chemistry are, or ever will be capable of *explaining*, in any precise sense, the greater part of vital phenomena and of life's manifestation, is so remote from the experimental facts, that it can be regarded as only a pure assumption.

The reviewer can find, then, only a minimum either of justification or of meaning in such claims as Professor Loeb's book purports to make, namely, that *all* human conduct, in morals, esthetics, scientific thinking and religion, is mechanistic. Nor is there any more justification or meaning for the view that it is provided only all such phenomena are mechanistic and can be related to physical chemistry, that there can be a science of them. One might as well claim that, until the brain is completely explained by physical chemistry, there can be no science of mathematics, since the mathematician's thinking is dependent upon his brain. Science is certainly not limited to physics and chemistry and their hybrid, physical chemistry; even where these sciences are not applicable, there may be description and explanation, hypothesis and confirmation, prediction and control, exactness and computation, causation and system.

But further, it may be asked, not as concerns Professor Loeb's methods, but as concerns his broad generalizations, What would they mean even if they were true? What, for example, does it mean to say that ethics, mathematics, literature, law, etc., are mechanistic? Does it mean anything more than that they are *consistent* with mechanistic principles in the technical sense or that the phenomena dealt with in these fields of knowledge are subject to the law of causation? But even with this meaning, would so saying help to understand, or to get at specific results in, the levels of phenomena with which these branches of knowledge are concerned? Would not these branches still continue to exist? And would not the phenomena with which they deal have to be scientifically investigated

at the higher level in order to find something subsequently to be reduced to, or explained by, mechanistic principles if possible? But with *everything* mechanistic in the sense only of being consistent with mechanistic principles, or of being caused, would there not still be something left over which would not be *identical with* mechanism in the precise and technical sense of that term? It is the conviction that there would be—a conviction which can be based on proof—that has actuated the reviewer to write this rather long notice of Professor Loeb's book. Everything that exists is not identical with nor explainable by mechanism in the technical meaning of the term, although it is compatible with it in the sense that one fact can not contradict or exclude the reality of another, and is in some relation with it. And all science is not physics, chemistry and physical chemistry. The tendency of many scientists to maintain the negative of these two propositions is a misleading influence and a stimulus to false hopes, especially when prominence in science lends its weight to the claim. But the tendency is not only a dangerous one; it also represents a bias which is contrary to that broad-mindedness which is held to mark the scientific mind. It is because Professor Loeb's book exemplifies this tendency to so marked a degree, that the opportunity of reviewing the book has been used to enter protest. As a collection of essays in the application of physical chemistry to biology one can only praise the volume. But as a philosophic work, which finds in this application ground for insinuating the universal validity of the mechanistic conception in some precise sense, but really making this only most general, one can only doubt and question. The scientist may justifiably resent the intrusion of the philosopher into science's realm, unless the philosopher becomes scientist. But when the scientist becomes philosopher, as does Professor Loeb, he exposes himself to that broader scientific criticism which is philosophy. The venture may be daring, but does not the daring only seem? For are not "we ourselves only chemical mechanisms"? Then where lieth the blame if some atoms become philosophers and in the combat some philosophers become atoms?

E. G. Spaulding

Princeton University

The Birds of Africa. By G. E. Shelley. Volume V., Part 2. Completed and edited by W. L. Sclater. London: Henry Sotheran & Co. 1912. Pp. viii + 165–502; pls. L.–LVII.

The publication of Captain G. E. Shelley's elaborate work on the birds of Africa was interrupted in 1906, after the appearance of the first part of the fifth volume, by the serious illness and consequent death of the author. Mr. W. L. Sclater, whose knowledge of the African avifauna well fits him to carry out the original plan, has undertaken to complete the work; and the present instalment is the first to appear under his supervision.

The general treatment of the subject is the same as in previous volumes. Brief diagnoses of superfamily groups, or "sections," are given; also keys to families and subfamilies; with diagnoses of families and keys to genera. Each genus is defined, furnished with proper synonymy, a key to its species, and in most cases with a statement of its geographical range. Under specific headings are given pertinent synonymy; descriptions of the adult plumage of both sexes, and, where possible, of juvenal and nestling; brief measurements, apparently of single birds; a general statement of geographical distribution, and a good account of habits, often two or three pages long, and including mention of many particular localities where the bird has been observed.

Little account is taken of subspecies, when recognized as such, and none are given separate headings. They are treated, if at all, in the text under their respective species, with sometimes a binomial, sometimes a trinomial name. Some are, however, considered as absolute synonyms; while a few are given full specific rank. Of those recognized as subspecies the synonymy is given, and usually, though not always, the diagnostic characters.

The book includes nominally 209 species

belonging to the following five families: Dicruridæ, Vangidæ, Campophagidæ [*lege* Campephagidæ], Laniidæ and Prionopidæ. The peculiar genus *Aerocharis* is here in the Vangidæ, but should constitute a family by itself—Aerocharidæ.

The genus *Edolius* is synonymized with *Dicrurus*, and *Abbottornis* with *Artamia;* while the several subdivisions of *Lanius* (*Fiscus, Enneoctonus, Phoneus* and *Otomela*), which have not even consistent color characters for their separation, are all given full generic rank. The generic name *Telophorus* Swainson is very properly given a place instead of *Pelicinius* Boie; but no satisfactory generic characters for the group so designated are given to separate it from *Chlorophoneus*, or either of these from *Laniarius*. The name *Tschagra* Lesson is used for the group commonly known as *Telephonus* Swainson, but this should be called *Pomatorhynchus* Boie, as contended by Dr. Reichenow.

Only a single species—*Vanga griseipectus*, from southern Madagascar—is described as new. Our author considers *Laniarius abbotti* inseparable from *Laniarius nigrifrons*, but it seems to us to be distinct. Likewise all the readily recognizable subspecies of *Dicrurus adsimilis* (here called by the preoccupied name *Dicrurus afer*) are ignored.

On the eight colored plates fourteen species, including the one here first described, are figured. These plates are by Mr. H. Grönvold, and remind us not a little of the work of the late Mr. J. G. Keulemans.

Harry C. Oberholser

BOTANICAL NOTES

ANOTHER AFRICAN PLANT ENUMERATION

A short time ago the writer reviewed Muschler's "Flora of Egypt",[1] and referred particularly to the absence of certain plants, or types of vegetation from the region included in that work (the lower Nile Valley, southward to Nubia), and now we have a contribution from South Africa which permits of some striking contrasts. This second publication is a "First Check-List of the Flowering Plants and Ferns of the Transvaal and Swaziland," by Professor Joseph Burtt-Davy and Mrs. Reno Pott-Leendertz,[2] constituting a 66-page octavo pamphlet, in contrast with the two volumes by Muschler. Yet in this little pamphlet we find enumerated 3,264 species, against 1,632 in the larger work. Moreover, the geographical area covered by the South African pamphlet (117,000 square miles) is less than half that covered by the Egyptian book.

Running rapidly through the check-list, the following numerical data attract attention. There are here recorded 97 species of ferns, including one *Marattia*, 5 Hymenophyllaceae and 78 Polypodiaceae. One finds also of *Equisetum* 1, *Lycopodium* 6 and *Selaginella* 5 species. The conifers are represented by *Podocarpus* (3 species) and *Widdringtonia* (1 species).

Of the grasses there are 146 native and 44 introduced species, the former including such genera as *Andropogon* (11 species), *Panicum* (19), *Eragrostis* (25), while of the sedges there are given 105 species (*Cyperus*, 27; *Scirpus*, 12; *Carex*, 10). Four palms are listed, and 189 Liliaceae (but no *Lilium*), with such genera as *Anthericum* (31 species), *Aloe* (17), *Scilla* (22) and *Asparagus* (13). Iridaceae with 79 species is notable for its 28 species of *Gladiolus*. So too we may note the 123 species of Orchidaceae (*Habenaria*, 23 species; *Disa*, 18 species; *Eulophia*, 31 species).

To give an opportunity for comparison we may mention further that there are 275 species of Leguminosae (*Acacia*, 33; *Crotalaria*, 12; *Indigofera*, 29) and 52 species of Euphorbiaceae. Anacardiaceae include 43 species (*Rhus*, 36); Tiliaceae, 25 species (but no *Tilia*); Violaceae, 2 species (*Viola*, 1); Ericaceae, 11 species (*Erica*, 10); Asclepiadaceae, 156 species (*Asclepias*, 28); Convolvulaceae, 62 species (*Convolvulus*, 14; *Ipomoea*, 37); Labiatae, 103; Scrophulariaceae, 138; Acanthaceae, 108; Cucurbitaceae, 230. Of Compositae there are 304 species (*Vernonia*, 14;

[1] Science, December 20, 1912.

[2] *Annals Transvaal Museum*, 1912.

Helichrysum, 59; *Senecio*, 36; *Aster*, 3; with no *Solidago*, and no *Helianthus*).

Of trees there are many species, but nearly all belong to genera unfamiliar to northern readers. Thus while there are two willows (*Salix*), one *Celtis* and 13 species of *Ficus*, there is no *Pinus, Picea, Abies, Ulmus, Fraxinus, Acer, Juglans, Quercus, Fagus, Castanea, Betula* or *Alnus*.

The authors are to be congratulated upon having brought out so creditable a list of the plants of their country, and we may express the hope of the botanists of the northern hemisphere that they will be encouraged to follow it soon with a descriptive manual.

GREENE'S "CAROLUS LINNAEUS"

AT the Linnaean bicentenary memorial exercises held in Washington Dr. Edward Lee Greene gave a notable address (now issued in a little book of 91 pages by the Cower Company of Philadelphia) in which he discussed with rare perspicacity and scientific sympathy the life of "the matchless Swede," Linnaeus. In it he discussed the lineage and childhood of Linnaeus, his school, college and university years; his journey to Lapland; journey to Germany and Holland; his practise of medicine in Stockholm; appointment to be a professor at Upsala, and his influence upon botany. Under the last head Dr. Greene says:

> It will be difficult to bring the average botanist of to-day to a realization of how great an epoch in botany Linnaeus created when he began examining the stamens of every plant, with the purpose of ascertaining into what one of his twenty-four proposed classes of flowering plants each generic type must fall. And though it be true that the classes and orders of Linnaeus fell into disuse three quarters of a century ago, it is true to-day that every botanist, from the mere beginner in taxonomy to the most accomplished master of it, if he have a new and unknown plant in hand for determination, makes his final appeal to stamens and pistils. . . . In this procedure every botanist who lives is distinctly a disciple of Linnaeus.

The last chapter of the little book, on Linnaeus as an evolutionist, was prepared two years later (1909) and brings out the fact that the great botanist was by no means the believer in the "fixity of species" that we have been led to believe. After quoting from the "Philosophia Botanica" which "excludes every idea of a possibly evolutionary origin for any species of plant," Dr. Greene says: "And yet, Linnaeus was an evolutionist," and proceeds to quote later statements which indicate that as the years went on he came to the view that some species may have been derived from preceding species.

The book should be in the hands of every teacher of botany, and we may add zoology, also, since there is a short but very suggestive chapter by Dr. Wm. H. Dall on Linnaeus as a zoologist.

CHARLES E. BESSEY

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SPECIAL ARTICLES

MAGMATIC DIFFERENTIATION AT SILVERBELL, ARIZ.

IN the course of a study of the ore-deposits of Silverbell, Pima County, Ariz., some interesting facts bearing upon magmatic differentiation were noted. A detailed description of this district has been published,[1] but as that paper is largely devoted to problems in economic geology, it seems advisable to summarize here the facts of interest to petrologists. The region described consists of a complex of late Mesozoic or early Tertiary intrusives entirely surrounding detached blocks of highly metamorphosed limestone. The igneous rocks in the order of intrusion are (1) alaskite, (2) alaskite porphyry, (3) granite, and biotite granite porphyry, and (4) quartz porphyry (dacite porphyry?). Many complex flows of basic composition are found just outside the area studied. The chief problem is the origin of the biotite granite, which is believed to represent a differentiation product of the magma from which the alaskites came.

The alaskite is a light gray rock, consisting almost entirely of quartz and orthoclase, the grains averaging about a half a centimeter in diameter. It contains a little plagioclase, and very rarely shows biotite or hornblende. It is bounded on one side by the later intrusion of

[1] *Bull. Amer. Inst. Min. Eng.*, May, 1912, pp. 455-507.

alaskite porphyry, but in all other directions it disappears under the detrital plains of the desert. The area exposed—about ten square miles—probably represents only a remnant of a more extensive intrusion. The alaskite porphyry, the intrusion next in age, is a rock with a fine felsitic ground mass, carrying phenocrysts of quartz and orthoclase seldom over a millimeter in diameter. It resembles the alaskite in composition, though showing more variation in kind of feldspar. An intrusive contact between the porphyry and the coarse alaskite was found, but the other limits of the porphyry do not fall within the region studied It was examined over an area of about three square miles. The biotite granite is a holocrystalline rock with an average grain of a quarter of an inch. It is composed of orthoclase, a little plagioclase, quartz and biotite, this last mineral sometimes forming phenocrysts. The relation of this granite to the other rocks is the most interesting petrologic feature of the district. It is found only in the alaskite porphyry, and occurs in three forms: (1) As irregular stocks about fifteen hundred feet in diameter, (2) as small bunches or lenses sometimes only a few feet in dimension, and (3) as well-defined dikes fifteen to twenty feet wide along the contact of the alaskite porphyry and the limestone blocks. In the first two cases the texture is holocrystalline and strikingly coarse even at the contacts. In the third case the rock is a granite porphyry—phenocrysts of quartz, feldspar and biotite in a glassy ground mass.

The fourth rock is more basic than the others, and may be a dacite porphyry, but the large amount of irresolvable ground mass makes its classification uncertain without chemical analyses.

The explanation offered for the above facts is as follows: The original rock magma was an acidic granite, which split into two parts, one rich in biotite, the other practically mica-free. The more acidic portion was intruded first, forming the alaskite and the alaskite porphyry. When the latter rock was only partly cooled, the biotite-bearing portion was intruded, working its way into the still pasty alaskite porphyry to form lenses, tongues and other irregularly defined masses. Along the borders of the alaskite porphyry cooling had gone further, clean fissures had been formed, and in such places well-defined dikes of granite porphyry resulted. This explains the intimate relationship between the granite and the alaskite porphyry, its various irregular shapes, and the coarse texture in some instances and the fine texture in others. There is a possibility that the quartz porphyry, which contains much biotite, is a still later intrusion of the biotitic phase of the same magma, but distinct evidence on this point is lacking. The relation between the quartz porphyry and the alaskites is not as close as between the granite and the alaskites. The quartz porphyry seems to belong to a distinctly later period of intrusion, while the granites and alaskites are of very nearly the same age.

Although aware of the objections urged against similar hypotheses, I am inclined to attribute the splitting of the magma into two portions to fractional crystallization and the sinking of the heavier biotite crystals. Whether or not this last point is well taken can not affect the conclusion that the granite is a later differentiation phase of the magma from which the alaskites came.

The origin of the granite has important bearing upon the genesis of the ore-deposits. These ores are contact metamorphic copper deposits in the limestones at the contact with alaskite porphyry. They are attributed to magmatic waters given off by the intrusive, in accord with the conclusions reached in similar districts by Kemp, Lindgren and others. But it is noteworthy that the richest ore is found in the neighborhood of masses of granite. Now if this granite is the final product of differentiation of the alaskite magma, it is very probable that it would bring with it increased quantities of magmatic water. The granite and the granite porphyry then partake somewhat of the nature of a pegmatite in that they represent final products of local magma splitting; they differ from pegmatites in texture, and from contemporaneous veins in general in their greater extent. The above facts

show a variation from the general law of decreasing basicity for plutonic intrusions, but this may be explained by the localized character of the phenomena.

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FERTILIZATION AND EGG-LAYING IN MICROCOTYLE STENOTOMI

Although the process of fertilization of the ovum is readily visible in those animals in which these elements meet outside the body in water, the actual behavior of the internal organs in those other animals where the process occurs within the body is seldom seen. It is for that reason that it seems desirable to describe it as studied in the transparent *Microcotyle Stenotomi.*

Copulation has been carefully observed and graphically described by Zeller in the case of *Polystomum integerrimum,* where the two vaginal orifices are at the lateral margins, but no other description has been found in the literature on the monogenetic trematodes, and in the case of the microcotylinæ is of special interest, since although hermaphrodites they can hardly carry out mutual copulation at the same time, as the vaginal orifice is median and dorsal while the penis is protruded from the ventral side.

Microcotyle Stenotomi, which occurs on the gills of *Stenotomus Chrysops,* is small enough (2.5 mm.) to become quite transparent when slightly compressed by the coverslip. If a number of these worms be placed alive in a watchglass full of sea water some of them will be seen to go into conjugation after certain repeated preliminary touching together of the anterior ends of the two bodies has taken place. In this passing of the anterior part of the body of one over that of the other the greatest acuteness of sensation is shown. However, after a certain amount of friction together, one worm almost spasmodically becomes fastened by its anterior ventral end, where the genital pore is situated, to the corresponding portion of the dorsal surface of the other in the position of the vaginal opening. They are therefore clasped together by the anterior ends, almost at right angles to one another, while still supporting themselves on their footlike sucker discs. Because the cirrus and surrounding genital aperture are generally provided with clusters of small hooks the pair is enabled to keep their position during the act.

The spermatozoa pass through the Y-shaped reservoir of the vitellaria to be stored in the seminal reservoir or spermatheca, whence it is ejected as required. A similar provision exists, as is well known, in many animals of more complete development.

In order to follow the later stages in the process of fertilization the worm must be put in a drop of sea water under the coverslip with a hair beside it to prevent too great crushing by the weight of the coverglass, and to allow of the normal movements of the genitalia. Anteriorly and ventrally is the genital pore through which the uterus opens. On the dorsal surface somewhat behind this is the orifice of the vagina. The ovary is a convoluted tube filled with ova which runs across the middle of the body, turning backward to end in an oviduct, while on each side of the body, occupying most of its cavity, is the vitellarium, giving off ducts which unite in a Y-shaped reservoir in the midline behind the ovary. Testes are present in a great group in the midpart of the body toward the caudal end.

In the ovary the ova are immature at the end of the organ, which is turned to the right; toward the other end, as the oviduct is approached, they become larger and mature. The oviduct may be seen proceeding toward the tip of the Y-shaped vitelline reservoir. Before reaching this it is joined by the duct of a small muscular sac which in this case is kidney-shaped and which is the seminal reservoir. If one is fortunate enough to see an ovum leave the ovary on its way toward the uterus, one can also observe that the seminal reservoir contracts spasmodically and injects a fine jet of opaline fluid into the oviduct toward the oncoming ovum, which on meeting the spermatozoa quickens its motion. It recedes a little, then advances again four or five

times as though to come thoroughly into contact with the seminal fluid. Then it passes quietly along the common duct until that is joined by the Y-shaped duct from which the granular yellowish fluid from the vitellaria is churned, as it were, into the oviduct and comes into contact wth the ovum surrounding and adhering to it. Continuing on its course the ovum passes into the wider ootype. Here by a vermicular moulding process the yolk is arranged round the ovum and the form of the egg begins to appear. From the ootype, when properly shaped, it passes along to the muscular portion of the uterine canal, which receives the openings of the shell gland. In *Microcotyle Stenotomi* the shell gland appears to be formed of a single mass of cells, the duct from which opens by a wide mouth into the uterus at this point. Generally, however, it is arranged as a mantle of cells about the first portion of the uterus opening by numerous perforations from which exude a chitinous fluid which becomes evenly smeared over the surface of the egg and forms the shell. The egg is now completed with the exception of the long chitinous filaments which are formed by the contractions of the uterus on the soft material. The completed egg passes along into the more distal part of the uterus, where it remains until the worm is ready to deposit it. For this purpose it proceeds to prepare by seizing with its anterior or oral suckers a piece of the gills, but in the case observed under the microscope a bit of waste material was fastened upon because it was convenient. The caudal disc of suckers was also fastened to some support, so that the body was slightly extended. Then a waving motion began, the waves traveling toward the anterior part from the caudal end of the body. After this had lasted for a few seconds the worm began to lash itself up and down, still retaining its hold on the débris to assist its muscular exertions. After the first lashing effort a portion of the anterior coiled filament appeared at the genital aperture; after a short rest a further violent expulsive effort occurred and the pointed end of the egg appeared externally. This was followed by another rest and then a still more violent expulsive effort which shot the egg against the waste material, where it remained fastened. The whole process was repeated after another short rest, until five eggs were laid, when a long rest ensued and the observation ended.

The process of laying the eggs occupied, all told, probably not more than a minute, but it was striking to see the display of some sort of intelligence by the worm in preparing for the expulsive efforts by seizing the waste material as a fixed point from which to pull.

Although this process of conjugation, fertilization and egg-laying could be directly observed only in this transparent form, it seems entirely probable that it is the same in all the microcotylidæ.[1]

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ANTHROPOLOGY AT THE CLEVELAND MEETING

The annual meeting of the American Anthropological Association was held at the Case School of Applied Science, Cleveland, Ohio, December 30, 1912, to January 2, 1913, in affiliation with Section H of the American Association for the Advancement of Science and the American Folk-Lore Society. In the absence of President Fewkes, Drs. Dorsey, Wissler and MacCurdy each presided at the various sessions. President Lomax, of the Folk-Lore Society was also absent, his place being taken by Dr. Charles Peabody, who read the presidential address.

SECTION H

Members of the sectional committee present: G. T. Ladd, E. L. Thorndike, W. V. Bingham, G. G. MacCurdy.

Officers for the Cleveland meeting were named as follows: member of the council, Dr. Clark Wissler; member of the general committee, Dr. Charles Peabody. Sectional offices were filled by the nomination and election by the general committee of Professor W. B. Pillsbury, University of Michigan, as vice-president for the ensuing year; Professor George Grant MacCurdy, Yale

[1] The above observations were made at the Laboratory of the U. S. Fish Commission at Woods Hole, Mass.

University, secretary to serve five years; and Professor R. S. Woodworth, Columbia University, member of the sectional committee to serve five years.

The question of a change of name from Section H, Anthropology and Psychology, to read "Section H, Anthropology," raised at the Washington meeting came up for discussion, and the sectional committee recommended that the name remain unchanged for the present.

ADDRESSES AND PAPERS

The address of the retiring vice-president of Section H, Professor George Trumbull Ladd, on "The Study of Man," is printed in this issue of SCIENCE. In the absence of President John A. Lomax, of the American Folk-Lore Society, his address on "Stories of an African Prince" was read by Dr. Charles Peabody. Some of the important papers read at the joint meeting are represented in this report by abstracts:

The Ceremonial Schemes of Certain Plains Indian Tribes: CLARK WISSLER.

Anthropology being essentially a science of culture, one of its necessary concerns is the distribution of cultural traits. In the distribution of such traits we have a complex problem, one of the first steps in whose solution is the description of each culture as found. The next and most interesting step is a comparative examination of these cultures. Were cultural traits all objective, this would be fairly simple, as is the case in many aspects of material culture; but many important traits are not very objective, especially those of a religious, ethical and social nature. When we come to compare religious conceptions of certain Plains tribes, we find a peculiar difficulty. First we are struck by the apparent absolute differences and the absence of all exact parallels. On closer inspection, however, we do find many units or subordinate traits that are exact parallels. It became necessary therefore to develop methods of handling this comparative problem.

It was noted that some tribes seem to have definite ceremonial schemes. The particular schemes for the Dakota, Blackfoot and Menominee were outlined and characterized as general patterns according to which almost every ceremonial was fashioned. The inference here is that if a tribe should take over a new ceremony the tendency would be to work it over into the tribal pattern. Examples of such making over of borrowed ceremonies were cited. The suggestion then is that in the comparative study of these tribal ceremonies allowance must be made for the deliberate change of pattern and evidences of contact sought in parallel units of a more detailed character.

Notes on Eastern Sioux Dances: ROBERT H. LOWIE.

The Santee, Wahpeton and Sisseton, though differing somewhat among themselves, shared a number of dances with the Plains tribes to the west, where these dances are usually practised by military societies. Among the Eastern Sioux, however, it is exceedingly difficult to determine whether the dances are performed by definite organizations or merely by a congregation of membership varying from dance to dance. The idea is prominent that some one individual, who has had a corresponding vision, must see to the performance of his particular dance, on pain of being struck by lightning if he failed.

Plate Armor in America, a Sinological Contribution to an American Problem: BERTHOLD LAUFER.

The paper is chiefly intended as a contribution to the much-ventilated question of historical methods applied to ethnology. Plate armor in northwestern America and northeastern Asia was hitherto believed to be due to contact with Japan, and interpreted as having been made in imitation of iron plate armor. From two important passages occurring in the Chinese Annals it becomes evident that bone plate-armor existed among the Su-shên, a tribe of presumably Tungusian stock, in the first centuries of our era, and the conclusion is reached that such armor can not have been made in imitation of Japanese plate-mail, which did not exist at that time. Also in China, Siberia and Korea, iron armor is not very ancient and develops almost contemporaneously with bone armor, which, however, is older than iron plate armor. It is pointed out that plate armor occurred also in western Asia and other ancient culture-groups, contrary to previous opinions, so that the problem is not truly historical, but rather amounts only to a technical question. The imitation theory, therefore, is highly improbable, and the independent origin of plate armor in the north Pacific culture-group must be maintained. Japan has never had any influence on the latter nor on American cultures, and American-Asiatic culture relations and exchanges must be studied in the light of the ancient ethnology and archeology of that region—particularly northern Manchuria and Korea—which remains to be reconstructed in the future.

The Development of Ancestral Images in China: BERTHOLD LAUFER.

The object of this paper is to show that the so-called ancestral wooden tablets serving at the present time in China for the worship of ancestors have developed from a former and very ancient concept of anthropomorphic ancestral images. The present mode of worship is briefly described, and the coexistence of tablets, conventional paper images and portraits is pointed out. The development of family ancestral worship is traced to the times of antiquity and explained as having its origin in hero and clan-ancestor worship, in the cult of which stone and wooden images were employed. These were, in course of time, transferred to the individual family ancestors. After a clear distinction between gods and ancestors had been reached, the images were reserved for the gods, the conventional tablets for the ancestors who, under the influence of the growing democratic tendency of this institution, themselves became more and more conventionalized.

The Separate Origins of Magic and of Religion: JAMES H. LEUBA.

Three types of behavior have been developed by man:

1. The mechanical behavior is the method of dealing with things. It implies a quantitative relation between cause and effect.

2. The anthropopathic behavior includes (*a*) the common relations of men and animals with each other, and (*b*) those of men with unseen beings. When these beings are gods, we have religion.

The desired results depend upon an agent endowed with intelligence and feeling.

3. The magical or coercitive mode of behavior, in which neither quantitative nor anthropopathic relations are involved. But magic may be used upon a personal agent. In that case the agent is neither prayed to, nor conciliated by offerings, but coerced.

Most of the varieties of magic may be accounted for by the following principles of explanation:

(*a*) Playful prohibitions. "If you do *this*," say our children, "*that* will happen to you." The "this" and "that" have usually no logical connection. Playful prohibitions may be taken in earnest and acquire a magical significance.

(*b*) Threats of untoward happenings made for the purpose of preserving things vital to the life and prosperity of the tribe.

(*c*) The motive which leads people to make vows.

(*d*) The spontaneous response of the organism to specific situations. The magical dances had probably this origin.

(*e*) The deliberate treatment of certain situations according to magical principles, for instance, that like produces like. This source of magic is, of course, relatively a late one, since it presupposes that a principle of magical procedure has been disengaged from magical practises.

With regard to *the origin of science*, Leuba maintains against Frazer, that the ancestor of science is not the magical but the mechanical behavior. The essential presupposition of science is that definite and constant *quantitative* relations exist. The clear recognition of that proposition means, whenever it appears, the death of magic and the birth of science. This fact indicates the opposition of the magical to the scientific attitude.[1]

Man and the Glacial Period in Kansas: N. H. WINCHELL.

The paper describes the topographic features of northeastern Kansas, relation of the continental moraine of the Kansan epoch, distribution of human stone implements with respect to the moraine and the terraces. It specially bears upon the patination of the artifacts, as indicative of the glacial age of the agent that formed them, calling attention to the similarity of these specimens to European paleoliths, and enumerating the kinds of implements that carry the distinctive patination, pointing out the succession of cultural stages that preceded the Neolithic and illustrating the contrasts which they present when compared with the Neolithic.

Evidences of Man's Great Antiquity: GEORGE GRANT MACCURDY.

A brief summary of the author's work in Europe during the past season and of the most important recent discoveries: the human remains of a very early type from Sussex; a Mousterian industry associated with a warm fauna (*Elephas antiquus*, *Rhinoceros merckii*, *Hippopotamus*) in the low (fourth) valley terrace at Montières, near Amiens; Torralba, an old camp site near the crest of the Sierra Ministra, Spain, where eolithic and paleolithic implements have been found intimately associated with the remains of *Elephas antiquus* (perhaps also *Elephas meridionalis*),

[1] See for developments Parts I. and II. of Leuba's book, "A Psychological Study of Religion; its Origin, Function and Future," Macmillan, 1912.

Rhinoceros etruscus, *Equus stenonis*, and two species of deer; the cavern of Castillo near Puente Viesgo, Spain, with its twelve relic-bearing horizons; Mousterian caves on the Island of Jersey; La Ferrassie, La Combe and Laussel (Dordogne); and the newly discovered cavern of Tuc d'Audoubert (Ariège), with its wall engravings and figures of the bison modelled in clay. The paper was illustrated by numerous lantern slides, for the most part in color.

The Carayan, Caririan, Chavantean and Guatoan Linguistic Stocks of South America: ALEXANDER F. CHAMBERLAIN.

Among the less well-known linguistic stocks of the South American Indians are the *Carayan*, *Caririan*, *Chavantean* and *Guatoan*, the first three of which are entirely, and the last particularly, within the area of modern Brazil.

1. *Carayan.*—The present center of the territory of the *Carayan* linguistic stock is on the Rio Araguaya and its affluents in the Goyaz country, south-central Brazil. The chief "tribes," or rather local divisions, of the Carayá are the Chambioa, the Javahé and the Carayá proper, the last consisting of two "hordes," a northern and a southern. Our best authorities on the Carayan stock are Coudreau, Ehrenreich, von den Steinen, Kissenberth and F. Krause, the most valuable material (a long Carayá vocabulary and one of over 100 words in Javahé) being found in Krause's "In den Wildnissen Brasiliens" (Leipzig, 1911). Coudreau, in his "Voyage au Tocantins-Araguaya" (Paris, 1897) gives a Carayá vocabulary of 380 words. Older vocabularies are given in de Castelnau, von Martius, etc. The family name, *Carayan*, is derived from Carayá, an appellation by which these Indians have long been known. Krause (p. 187) says that the Carayá proper call themselves "kărājă', kărădjă' and also krădjá."

2. *Caririan.*—The territory of the *Caririan* linguistic stock originally included a considerable portion of eastern Brazil, in the provinces of Bahia, Pernambuco and Piauhý, north, south and west of the Rio São Francisco. These Indians were Christianized in the middle of the seventeenth century, but at most a few hundreds now survive in the valley of the lower São Francisco. With the Carirí proper belong also the Sabuyá, who dwelt somewhat further south. Our chief sources of information concerning the Carayan language, besides the older missionaries (Mamiani, de Nantes, et al.), are von der Gabelentz, Galvão, Platzmann (who have all republished or edited catechisms and grammars of the missionaries), Adam, Ehrenreich and von den Steinen. A Sabuyá vocabulary of over 100 words is given by von Martius. The family name, Caririan, comes from the appellation of the northern section of this stock, which appears variously as Carirí, Cairirí, Cayriry̆, Kirirí, etc. The etymology is unknown.

3. *Chavatean.*—The territory of the Chavatean linguistic stock lies in the region of the upper Paraná and lower Parapanemá (about 20° s. lat., 52° w. long.), in São Paulo, Matto Grosso and Paraná (Brazil). These "Chavantes" (v. Ihering seeks to call them "Eo-Chavantes") are not to be confused with the Tapuyan "Chavantes," or "Akua," of Goyaz and Matto Grosso. The linguistic material of the Chavatean stock consists of two short vocabularies by T. M. Borba and F. R. Ewerton-Quadros, both of which are reprinted by Professor H. von Ihering, our chief authority, in his "The Anthropology of the State of S. Paulo, Brazil" (2d ed., S. Paulo, 1906). The family name, Chavantean, comes from "Chavantes" (the etymology of the word is uncertain), a term applied to several Indian peoples of this region.

4. *Guatoan.*—The territory of the Guatoan linguistic stock includes part of the northern Chaco and the region about the confluence of the Paraguay and the São Lourenço, particularly the country about Lakes Gaiba and Uberabá. The Gaiba have been visited and described by Kowslowsky (1894), Monoyer (1905), Schmidt (1900–01 and 1910). Our chief authority is M. Schmidt, whose interesting book, "Indianerstudien in Zentralbrasilien" (Berlin, 1905), contains a section on word-formation, a long classified vocabulary, some sentences, etc. An older vocabulary of 160 words is reproduced in von Martius from de Castelnau. Schmidt's résumé of his expedition of 1910 is to be found in the *Zeitschrift für Ethnologie* for 1912. The family name, Guatoan, comes from Guató (Vuató, Quató, etc.), the name by which these Indians have long been known. No satisfactory etymology is on record.

Material Relating to Californian Indians in E. Tesa's Saggi Inediti di Lingue Americane (Pisa, 1868): ALEXANDER F. CHAMBERLAIN.

Professor Emilio Tesa's "Saggi Inediti di Lingue Americane"[1] is so largely taken up with

[1] "Saggi Inediti di Lingue Americane. Appunti Bibliografici." In Pisa. Dalla Tipografia Nistri. MDCCCLXVIII., pp. 91.

the consideration of South American Indian languages that the material therein relating to certain Indian peoples of North America seems to have been rather overlooked. Pilling, who, in his "Proof Sheets,"[3] cites Teza, observes (p. 754): "Mainly devoted to South American languages; but contains a brief discussion and a few examples of Algonkin and Iroquois, pp. 14–22. Our Father in Tarasco, pp. 60–62." Through the courtesy of the library of the University of Pennsylvania, Chamberlain has been enabled to consult the copy of Teza belonging to the Brinton collection, once the personal property of that great Americanist. A colophon, at the end, informs us that "the 'Appunti' were published in the *Annali della Università di Pisa*, MDCCCLXVIII., Vol. X.," and that "of this Edition in octavo, to which has been added an Appendix, only LXX. copies were printed, and they are not for sale." It is the "Appendice," occupying pages 77–91 (pages 77 and 78 are blank) of the octavo edition of 1868 that interests us here, for it contains ethnological and linguistic information concerning some of the Indian tribes of California. On pages 80–86, under the heading, "Balli de' Californesi," is printed the Spanish text of an account by "P. Jak" of ball-games and dances of certain Californian Indians. Those mentioned are: "Jumos, apaches, dieguinos christianos, sanluisenos, que somos nosotros, sanjuanenos, gabrielenos, fernandinos; y los de Monte Rey." The Luiseños are said to play well the ball-game of *uauquis*. One game is termed general, and "nostros llamamos tannis, bailar, o mejor dar patadas." On pages 81–84, 84–85, 85–86 are given, respectively, descriptions of the "Primer baile," "Segundo baile," "Tercero baile." A number of Indian words are scattered through these descriptions. On pages 87–91 are given the native texts and Spanish versions of "Versi Californesi"—two poems composed by P. Jak in the Indian language (the translations are also by him). The dialect represented is probably Luiseño.

Pages 22–30 of the "Saggi Inediti" are also concerned with Californian Indian languages, and on pp. 24–26 P. Jak discusses the grammar of Luiseño. On page 23 we are informed that P. Jak had composed a "Prima lingæ Californiensis rudimenta," ca. 50 pages, and containing "a little of everything." The chief source of information was "a Californian of S. Luis, converted to Christianity," and the thing was done "to please Cardinal Mezzofanti." Teza's whole book, of course, owes its existence to Mezzofanti's linguistic collections.

A Note on Child-invention: ALEXANDER F. CHAMBERLAIN.

That invention (conscious or unconscious) by children, with subsequent adoption by adults of the community, has played a not unimportant rôle *sometimes* in the development of human culture is a theory known in ethnological literature, especially in connection with the evolution of language (von Martius, Peschel, Farrar, Newell, Hale, Krauss, Sartori, Lasch, et al.). The inventiveness of children in plays and games has also had some influence upon primitive society and even upon its civilized successors. Chamberlain has already discussed some aspects of "child-invention."[4] Seldom, however, is one fortunate enough to be present when such an addition to the stock of human knowledge is actually being made. The chronicling of such events by travelers and ethnologists among the more or less primitive peoples still in existence is a matter of interest to the historian of human civilization. A curious example of "child-invention" is reported by A. de Calonne Beaufaict, in his recent book of African studies,[5] in writing about the people of the islands of the Uelé, above the Mokwangu rapids, in the northern Congo country.

After calling attention to the fact that the mentality of these Bakango Negroes is not at all of such a stagnant and passive sort, as, *e. g.*, M. Goffin attributes to them in his "Pêcheries et Poissons du Congo," by virtue of which they "must be incapable of taking advantage of and permanently acquiring for themselves the thousand and one little accidental inventions, which, in normal times, pass unnoticed, but to which every critical period gives a special value," and stating that he has often had the opportunity to observe just such cultural acquisitions, the author says (p. 56, footnote):

"One of the most amusing was the invention by a young Mobenge of a bolas to catch fowl. He was gravely imitating angling, with a stick and a *liana*, to which was attached a corn-ear

[3] "Proof Sheets of a Bibliography of the Languages of the North American Indians," Washington, 1885.

[4] See "The Child and Childhood in Folk-Thought" (New York, 1896), pp. 249–269 and 273–275.

[5] "Etudes Bakango" (Liège, 1912). See p. 56 and footnote.

serving for a fish. One of his brothers came running along, in pursuit of the fowl that had to be safely shut up away from the little carnivora. The boy held out his stick, to cut off the retreat of the frightened fowl, which got entangled in the *liana*, fell down, and was captured. Put into good humor by this grotesque accident, the inventor made a second successful attempt. The next evening, the family were supplied with the apparatus; and my *boys* imitated it. And, perhaps, in a few years, some descriptive ethnologist will report that the Mobengé used the bolas, and, from that fact, will infer some ethnological theory as to the origin of the tribe.''

This example is of more than ordinary interest, since it involves not merely ''child-invention,'' but likewise transference from one form of culture-activity to another—from fishing to bird-catching.

Description of the Tsantsa:[6] H. NEWELL WARDLE.

A macroscopic description of one of the rare mummified heads of the Jibaros of Ecuador, with considerable detail as to color, form, size and ornamentation together with the weave of the suspension cord.

The Principles of Limited Possibilities in Ethnology:[7] A. A. GOLDENWEISER.

In the present state of ethnological enquiry the reality of convergent developments can no longer be doubted. The actual demonstration of such convergence on general theoretical grounds, therefore, seems highly desirable.

The principle of limited possibilities implies that whereas the origins of cultural processes are innumerable, the processes soon become reduced to a relatively smaller number of types, while the relatively stable products of these processes are strictly limited in number, owing to the play of certain objective and psychological factors. If that is so, there must be convergence. The principle of limited possibilities is thus constituted an *a priori* argument for convergent development.

Three Forms of the Human Nose: ROBERT BENNETT BEAN.

The three most distinct forms of the human nose appear characteristically in different parts of the earth and the forms are clearly geographical, evolutional and developmental. The first of the three is the underdeveloped nose resembling that of the infant, and this form has been called by Dr. Bean the Hypo-phylo-morph; the second is a massive nose, the Meso-phylo-morph; and the third is the thin, high, long, narrow nose, the Hyper-phylo-morph.

The Hypo-phylo-morph nose is flat, broad and short, with flat depressed bridge, upturned tip, and the nostrils open forward rather than downward. The nostrils flare and are wide open, and the extremity may be inserted horizontally along the floor of the nasal fossa without interference by the alæ. The nasal ridge, or the bridge of the nose, is flat, because the nasal bones do not form a steep roof over the nasal passages by their opposition along the median line. The articulation of the nasal bones with the frontal bone is a gentle curve and not an abrupt transition. The supraorbital ridges and glabella are not prominent, nor the frontal sinuses large in association with this form of nose, but the cheeks are full, and the eyes prominent, therefore the front of the entire face is somewhat flat, although the lips project from a small mouth. The Hypo-phylo-morph nose is essentially the nose of the infant.

The Hypo-phylo-morph nose is found especially among the Malays and Negritos as they exist to-day in the Malay peninsula, Java, Sumatra, Borneo, Celebes and the Philippine archipelago, as well as among the Pigmies, Bushmen and Hottentots of Africa. It is also found in a modified form in Burma, Siam, Cambodia, Tonkin, Annam, in India, China, Japan, Mongolia and among the true Negroes of Africa and America. The form dwindles away through Siberia, Lapland, Finland and Russia into Europe, where the Hyper-phylo-morph nose appears. The form also dwindles away through the Eskimos and Indians of the Americas, among the Polynesians and the other inhabitants of the Pacific Islands and among the pseudo-negroes of north and east Africa, in all of which peoples the Meso-phylo-morph nose appears. It is most emphatic among the women of all the countries where it appears, but is also to be seen among the men.

The Meso-phylo-morph nose is massive, long and broad, not very high, with apparently depressed root due to overhanging brows and glabella, it has a straight bridge and nostrils that open downward and slightly forward. The outlines of the nose are usually straight. Looked at from in front the lines of contact of the nose with the face on each side are straight, and slant

[6] To be printed in the *Proceedings of the Academy of Natural Sciences*, Philadelphia.

[7] The paper appeared in full in the *Journal of American Folk Lore*, September–December, 1912.

away widely from the inner angles of the eyes to the alæ of the nose. Looked at from the side the bridge of the nose is straight or very slightly aquiline from root to tip, and the lower border (base) of the nose is straight from a point just over the akanthion to the tip of the nose, although the tip may dip below this straight line sometimes. This line is not long in relation to the breadth of the nose, but it is absolutely as long as the same line in the Hyper-phylo-morph nose, and may even be longer when the nose is unusually large. The nose looks flat, due to its great breadth, when it is actually a high nose. The alæ flare little, although the apertures of the nostrils are large, due to the great width of the nose. The nasal bones form a more acute angle at their apposition than in the Hypo-phylo-morph nose, and they pass abruptly above into the frontal bone, where the overhanging brows and glabella give the root of the nose a depressed appearance. The malar and zygomatic bones are large and project, and the jaws are prominent both in front and at the sides of the face. The orbits are large, the bony sinuses about the nose are of great size and the lips are thick. The result is that the whole face is large and the nose conforms with its surroundings.

The distribution of the primary forms of the Meso-phylo-morph nose centers among the inhabitants of the Deccan and Ceylon, among the Polynesian and the inland tribes of the Philippine Islands, Java, Sumatra, Borneo and Celebes, and it assumes its most exaggerated form among the Tasmanians, Australians, Melanesians, pure Negritos and true Negroes. The form exists somewhat modified among the peoples who have the Hypo-phylo-morph nose, and is especially emphatic among the men, although it appears among the women. It fades away through northern Asia, in central Europe, through southern Asia towards the Mediterranean basin and in eastern and northern Africa, at all of which points it merges into the nose of the Hyper-phylo-morph.

The Hyper-phylo-morph nose is long, high and narrow, with high root, bridge and tip, the nostrils flare but little and open almost directly downward. The nostrils may even open somewhat backward in the exaggerated forms, as in the Jew, for instance. The nose appears prominent and may seem larger than it really is, inasmuch as the jaws are not prognathous, and the brows and glabella do not overhang the nose; the forehead and chin may even recede, leaving the nose projecting from the middle of the face. The nose may be retroussee, straight, sinuous or aquiline. The retroussee seen chiefly among women, is the underdeveloped, whereas the aquiline, seen chiefly among men, is the exaggerated form of the Hyper-phylo-morph nose. Associated with this form of nose is the long, narrow face and the long, high, narrow head. The distance from the external auditory meatus to the tip of the nose is greater in this form than in either of the others, and this projection of the nose to a pointed tip in association with the high, narrow forehead and pointed chin give the characteristic appearance called by the Australians in derision, "the hatchet-faced Englishman."

The most representative types of the Hyper-phylo-morph nose in its primary form are found in northern Europe, Great Britain and America, among the tall blond Nordics, and this form of nose has been modified around the Mediterranean, where it is extremely fine and thin. Its most exaggerated forms are to be seen among the Jews, Arabs and Gypsies. It is found more or less modified in Asia and Africa along the course of four streams of infiltration. The most intense forms (the most perfect) are in southern Asia and northern Africa, the least intense in northern Asia and eastern Africa. The American Indians present a Hyper-phylo-morph nose of an intermediate form between that of the extreme Meso-phlyo-morph and the primary Hyper-phylo-morph. The characteristic Hyper-phylo-morph nose dwindles in purity and frequency through southern Asia and northward through the hearts of the large islands of the Pacific among the inland tribes, except among the Tasmanians, Australians and Melanesians, to the inland tribes of the Philippine Islands, and eastward into Polynesia; through northern Asia into China and Japan, where in the latter place the nose is similar to that of the Mediterranean peoples; through northern Africa into the Soudan to the Guinea coast; and through eastern Africa to the Congo and along the south and east coasts up to the Guinea coast and the Congo again. The peoples who have this form of nose in greatest purity may be enumerated as follows: Danes and Scandinavians, North Germans, British, American whites in the United States and Canada, Spanish, Portuguese, some southern French and Italians, Greeks, Turks, Arabs, Jews and Gypsies. Those peoples among whom modified, yet fairly typical, forms are frequent are: East Indians, Iranians and Turanians,

North and East Africans, Europeans other than those previously mentioned, Chinese, Japanese and Thibetans, Polynesians and Micronesians, and the inland tribes of the great islands of the Pacific, Java, Sumatra, Borneo, Celebes and the Philippines.

The three forms of the nose may appear pure among any people, and in differentiating the three forms in any locality I use the terms Hypo-onto-morph, Meso-onto-morph and Hyper-onto-morph, because in every individual it may not be clear that the form of the nose is due to evolution—it may be developmental. The -onto-morph noses are not so strikingly different as the -phylo-morph forms, but in any case the Hypo-onto-morph resembles the Hypo-phylo-morph, the Meso-onto-morph resembles the Meso-phylo-morph and the Hyper-onto-morph resembles the Hyper-phylo-morph.

The Nose of the Jew and the Quadratus Labii Superioris Muscle: ROBERT BENNETT BEAN.

The peculiar position of the Jew for centuries may account for the origin of the Jewish nose. The shape of the nose depends upon inherent and extraneous influences. The latter do not concern us at present. Of the inherent influences, alterations in the bones of the head and face cause changes in the shape of the nose; increased vascularization of the nasal mucous membrane and the erectile tissues of the nose, as in continued excessive sexual indulgence, may alter the shape of the nose; and the muscles attached to the nose may change its form.

The quadratus labii superioris muscle has four parts, all of which center around the alæ of the nose and the base of the upper lip, and from there they radiate towards the eyes in the shape of an imperfect fan. The two extremities of the fan are attached, the one at the root of the nose, the other to the ventral surface of the malar bone. The part of the quadratus muscle attached to the nose is called the angular head, which has two slips, one rising from the nasal bone and inserting into the cartilage and tissue about the ala of the nose; the other rising from the upper part of the nasal process of the maxilla near the inner canthus of the eye and inserting into the skin and fascia at the base of the upper lip midway between the center and the side of the mouth. The angular head has been called the levator labii superioris et alæque nasi muscle, a term that expresses its action. The muscle slips pull the ala of the nose upward and backward, depress the extremity of the nose and help to elevate the upper lip and deepen the naso-labial groove. The two remaining portions of the quadratus muscle are called the levator labii superioris and the zygomaticus minor, which form the infraorbital and zygomatic heads, respectively. They rise from the maxilla and malar bone beneath the orbicular muscle and are inserted into the skin and fleshy part of the upper lip near the corner of the mouth. They pull the upper lip upward and backward and deepen the naso-labial groove. Deepening of this groove gives an expression of sadness, which is intensified by sorrow or grief. Assisted by the great zygomatic muscle and the caninus, the quadratus draws the tissues covering the chin upward and backward, pulls the corner of the mouth in the same direction and deepens the naso-labial groove. This sharpens the chin and makes it appear to tilt upward in the form of a beak. The depression of the point of the nose tilts this member downward and gives it the appearance of an inverted beak. The mouth is at the same time drawn back, and the double beak becomes more emphatic.

The quadratus muscle is said to produce expressions of the face that indicate a great variety of emotions, all of which may be grouped as related to indignation. It is essentially the muscle of disgust, contempt and disdain, which lead to scorn, acknowledging guilt. Discontent follows, with a snarl, sneer and defiance; after which come bitterness, and a menacing attitude, with pride. Indignation, anger, rage and hatred rapidly succeed each other. This complex of emotions may be superseded by sadness, grief or sorrow. That one small muscle group can express so many emotions is almost inconceivable, but upon intimate analysis the nineteen words used to enumerate the emotions expressed by the quadratus muscle are related, or proceed the one from the other in natural sequence.

The expression of the Jew is that which would result from very strong contraction of the quadratus muscle. The nose is depressed, and this is so marked that often an obtuse angle is made at the junction of the cartilage and nasal bones, which leaves the cartilage slanting very little and at times vertical. The nose of the Jew is large, and the depression of the tip increases the prominence of the bridge and adds to its apparent size. The ala looks pulled upward and backward, a furrow is seen around the ala and the naso-labial groove is deep. The upper lip and the corner of the mouth appear pulled upward and backward

and the tissues of the chin are drawn, giving the beaked look. This characteristic is not well marked on all Jews, being more emphatic on some than on others; it is also to be seen on those who are not Jews, but it is more pronounced on Jews than on other peoples, and that it is a Jewish feature can not be doubted. Having become a recognizable characteristic, it was used in sexual selection. Those who showed it most strongly would be selected in marriage by the most orthodox, and would transmit a natural endowment to their offspring. Those who gave less evidence of it might marry outside of the race. In this way the feature became fixed, and it is as much an inheritance as any other characteristic. The peculiar position of the Jew for centuries may account for the origin of the Jewish nose.

The papers read of which the secretary was unable to obtain abstracts were:

Abnormal Types of Speech in Nootka (to be published by the Geological Survey of Canada): Edward Sapir.

Paiute and Nahuatl: A Study in Uto-Aztekan (to appear in the *Jour. de la Soc. des Américanistes de Paris*): Edward Sapir.

The Individual Totem among the Interior Salish: C. M. Barbeau.

Some Comparative Aspects of the Wyandot Language: C. M. Barbeau.

Magical and Religious Factors in the Development of the Human Will: Felix Krueger.

Fallacious Estimates of Prehistoric Time: G. Frederick Wright.

The Father and Son Combat in British Balladry: Phillips Barry.

The following papers were read by title:

Social Organisation of the Menominee: Alanson Skinner.

An Archeological Survey of New Jersey: Alanson Skinner.

Pigmentation and Longevity: Wm. C. Farabee.

Numerical Systems of Campa and Pano: Wm. C. Farabee.

The Japanese New Year: Mock Joya.

What is the American View of Totemism: Charles Hill-Tout.

Preliminary Report on Excavations in Southern France: Charles Peabody.

Dr. Peabody preferred to give his time to the reading of Dr. Lomax's presidential address.

George Grant MacCurdy,
Secretary

Yale University

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

A special meeting of the Anthropological Society of Washington was held January 7, 1913, in room 43 of the new building of the National Museum, the president, Mr. George R. Stetson, being in the chair.

Mr. E. Dana Durand, director of the Census, read an important paper on "Race Statistics of the Last Census," replete with interesting facts. Mr. Dana said, *inter alia*, that during the decade 1900–10 the white population of the United States increased about 22 per cent. and the negro about 11 per cent. This difference is partly due, however, to the direct or indirect effect of immigration of whites, in the absence of which the whites would have increased about 14 per cent. The Indians increased about 12 per cent., the Chinese decreased in number, while the Japanese nearly trebled. The whites have at practically every census shown a more rapid rate of increase than the negroes, and there is reason to believe that the difference between the two races in rate of increase from 1890 to 1900 was greater than appeared from the census returns, on account of a probable underenumeration of the negroes in 1890. The census of 1910 showed that about 21 per cent. of the negroes are mulattoes, as compared with about 12 per cent. in 1870, the last preceding census at which the question regarding blood mixture was asked in comparable form.

There has been no very great migration of negroes out of the south, nearly nine tenths of the total number being still found in that section. The number living outside the south increased 167,000 between 1900 and 1910, while the number residing in the south increased over 800,000. The rate of natural increase—that is, by excess of birth over deaths—of the white population of the south, however, is much higher than that of the negroes, being higher also than that of the whites in the north.

Among the native white population whose parents were born in this country, there were, in 1910, 104 males to each 100 females, as compared with only 98.9 in the case of the negroes. Among all classes of the population more boy babies than girl babies are born, but equality tends to be brought about by a higher death rate among the males. The difference in sex distribution between the whites and the negroes is probably attributable, in part at least, to more favorable health conditions among the whites.

The age distribution of the native white population is somewhat different from that of the negroes, probably chiefly on account of a lower death rate among whites, tending to greater longevity. There has apparently been a very marked decline in the birth rate among negroes in recent years, while there has been a gradual but less marked decline in the birth rate of the whites during each decade for a long period of time.

Negroes tend to marry earlier than the native white classes; and, in fact, at all age periods the proportion of married, widowed and divorced persons, taken together, is higher in the case of the negroes of both sexes than in the case of the native whites of native parentage.

There has been a marked change in the composition of the foreign-born population of the United States during recent years. Natives of northwestern Europe constituted more than two thirds of the total foreign-born population of the United States in 1900, but less than half in 1910, while southern and eastern Europeans formed only a little over one sixth of the total at the earlier census, as compared with three eighths in 1910. The Germans and the Irish particularly have fallen off conspicuously in numbers, while the natives of Russia—largely Russian Jews and Poles—Austria, Hungary, Italy, Greece and other countries of southern and eastern Europe have increased by very high percentages, no less than 1,090 per cent. in the case of natives of Greece. The natives of Russia now rank second among the foreign-born classes, and those of Italy fourth.

The speaker answered inquiries of various members as to sundry items, and these questions were accompanied by brief statements contributing further facts and explanations, but there was no extended discussion.

WM. H. BABCOCK,
Secretary

THE ACADEMY OF SCIENCE OF ST. LOUIS

AT the meeting of the Academy of Science of St. Louis on January 20, Mr. S. Bent Russell read a paper on "Demonstration and Design of Apparatus to Simulate the Working of Nervous Discharges."

Professor J. L. Van Ornum, of Washington University, spoke on "Experiments on the Pointing of Pressure Tubes to Eliminate Velocity Effects in Water Pipes."

Professor F. E. Nipher, of Washington University, communicated to the academy the results of recent experiments which seem to indicate that the strength of a steel magnet depends upon its electric potential. The magnetic moment determined by the Gaussian method of deflection appears to be a maximum when its negative potential is somewhat less than that of the earth.

The magnet consists of a single layer of steel wire having a diameter of .022 of a centimeter wound longitudinally on a hollow conducting cylinder 30 centimeters long and 2½ centimeters in diameter. The needle acted upon by this magnet is completely enclosed in a copper screen. A mirror on the needle is observed through a glass window covered with copper gauze of .1 inch mesh. The needle is held in the magnetic meridian by means of an ordinary magnet serving to balance the deflection due to the wire filaments constituting the magnet to be tested. This magnet is insulated and connected with either terminal of an influence machine, the other terminal being grounded. No disruptive discharges are permitted to occur.

When the magnet to be tested is connected with the positive terminal of the machine the needle is slowly deflected over an angle of about 4 minutes of arc in about one fourth of an hour. When the magnet is disconnected the needle returns to the zero position in about the same time interval. This may be repeated many times. The magnet becomes stronger while in contact with this terminal.

When connected with the negative terminal similar effects are produced, but the magnet becomes weaker instead of stronger.

When the magnet is freshly magnetized it does not wholly recover its strength when it is enfeebled by connection with the negative terminal, but it approaches a condition of permanence when the operation is repeated.

This result is similar to the well-known fact that the attraction between masses of matter depends upon their electric potential.

Professor Nipher suggested that plating the steel wire, of which the magnet is composed, with a film of non-magnetic matter is likely to lead to results of great interest.

G. O. JAMES,
Corresponding Secretary

ST. LOUIS,
January 24, 1913

SCIENCE

FRIDAY, MARCH 7, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

PHYSICS AND DAILY LIFE[1]

THE school system of Germany has often been held up to the teachers of this country as a model of perfection. Germany has been called a nation of schoolmasters, and the wonderful progress of its industries has been attributed in no small measure to the rigid training and high efficiency of its gymnasia, its universities and its vocational schools. Even at the present moment our country is being urged on many sides to establish alongside the regular public secondary schools an independent system of vocational schools, the chief argument in favor of this plan being the fact that it was "made in Germany."

Notwithstanding the fact that the reputation of the German schools is so brilliant on this side of the Atlantic, there are many thoughtful and earnest dwellers in the Fatherland who consider the training given by their schools to be of very doubtful educational value. Thus, some twenty years ago Emperor William II. called a congress of the leading schoolmen of Germany to consider what could be done to bridge the chasm that yawned so wide and deep between the work of the schools and the daily lives of the pupils. Little was accomplished as the result of this congress. The schoolmen declared it were little short of sacrilege to experiment with schools, which had always enjoyed a reputation for perfection equaled only by that of the medieval monks. Since that time, the vocational and industrial schools of Germany have developed alongside and, in large

[1] Presented at the conference of the University of Illinois with the secondary schools of the state, November 22, 1912.

measure, independent of the "regular" schools. This unfortunate double system of public schools was made necessary because of two relentless and irreconcilable facts: namely, (1) the needs of the people; and (2) the "conservatism" of the schoolmen.

In spite of the fact that the vocational schools of Germany did bring education and life nearer together for the working classes, the children of the intellectual classes continued their double existence in the world and in the school respectively until very recently. Day has, however, now begun to dawn on the academic landscape, and efforts, which originated among the teachers of science, are now being made to establish some semblance of a relationship between the school routine and the daily lives of the pupils. The evils that are being eliminated are over-systematization, rigid uniformity and the belief that words, signs and symbols can be made to serve in the educational process in place of concrete materials and real problems.[2]

Many will doubtless recognize the similarity between the experiences of Germany and those through which this country is now passing in the matter of bringing school and life to have something in common besides the children themselves. The needs of the masses for vocational schools are only equaled by the needs of the pupils in the regular schools for mental pabulum that nourishes them and helps develop their characters. Can you doubt this in the face of trustworthy reports, like that of the City Club of Chicago, which show that the present public school system fails to reach more than half of the school population? If so, study the statistics of elimination and retardation and be impressed by the enormous annual waste in material resources thus caused—the much more impressive and disastrous waste in human resources can never be calculated.

In this state of Illinois, as you all know, the crisis is imminent. The state legislature is considering a bill for the authorization of a second independent system of schools, intended in some measure to atone for the shortcomings of the present public schools. The chief argument in favor of the proposed plan is that the schoolmen who are now in control are both incompetent and unwilling to reorganize their work so as to meet the needs of that half of the school population which is not benefited in any marked degree by the present system. In support of their argument, Germany is held before us as a model, and we are urged that, as it is in the Fatherland, so must it be here. In other words, the incompetency of the teachers in permitting the proven inefficiency of the schools to continue is condoned, and we are invited to authorize additional expenditures on the ground that others, not schoolmen, can succeed where we have failed.

What would a captain of industry think of an analogous proposition with regard to his manufacturing plant? Suppose that a plant and its employees wasted half of the raw material supplied to it; would the manager enlarge the plant and take on more hands of a different sort in an endeavor to reclaim some part of the original waste? Yet the idea is abroad that this sort of a procedure, obviously absurd in an industrial enterprise, is, nevertheless, justified in school practise. The basis for this idea seems to be the fact that teachers are supposed to be so conservative that they are unwilling even to consider a new idea, much less to adopt it.

We teachers, naturally enough, repudi-

[2] Ostwald, "Wider das Schulelend," Leipzig, 1909; Gutzmer, "Die Tätigkeit der Unterrichtskommission der Gesellschaft deutscher Naturforscher und Aerzte," Leipzig, 1908.

ate this accusation. We pride ourselves on being the most progressive of all people. Do we not all use our last bit of strength to keep up to date? Yet, where there is so much smoke, there must be some fire. It behooves us then not merely flatly to deny the charge, but rather to analyze carefully our methods and results in the effort frankly to discover wherein we have given ground for popular misconceptions.

This analysis might be found to be a difficult, not to say embarrassing, undertaking if it were not that the problem may be stated in a somewhat different way which permits of a ready answer. Instead of asking what grounds we have given for a reputation of ultra-conservatism, we may ask whether we have as yet succeeded in bringing the school work close to the lives of the pupils. After graduation our education and our lives are most inextricably entangled. Is it so before graduation? For if it is, the problem of vocational education vanishes. If the life of the child is his education, or if his education is his real life, he is developing to serve society to the full extent of his abilities. But if this is not true, if his schooling and his life are to him two strangely incompatible forms of existence, then there is something radically wrong with the school. Are we then making education and life a unified existence for the pupils?

The answer to this question must be an unequivocal *No*. The simple fact that this conference and other similar conferences all over the country are considering how to bring schoolwork close to child life is complete proof of the correctness of this answer. We teachers stand convicted by our own acts. We recognize that we fail at this vital point.

But even though we fail, are we willing and ready to improve and constantly to work for a closer union of education and life? Here the answer is equivocal: some are, and some are not. Some are willing to try, but are placed in circumstances where they are not free to make the effort. They are blocked by the authority that works from above downward—particularly the latter. Others express in words their willingness to make the trial, but continue in deeds to run along in the same old rut. Still others are eager to break away from the present system and to strive for a more efficient one, but they do not know where to begin. In the hope of helping such as these in gaining a vantage-ground from which to work for the union of education and life, the following hints are given. They constitute a brief summary of the main points of agreement among those who have in some measure succeeded in breaking loose from tradition and from the vested interests of school paraphernalia and equipment.

The first of the false gods that holds and will forever hold education and life asunder is the idol of uniformity. How this graven image ever came to be given an honorable place in the temple of learning passeth all human understanding. The genius of a man, the characteristics that mark him off from his fellow men and give him his priceless personality, are his individual differences. It is because he has traits and combinations of traits which are different from those of any other man that he is interesting and powerful or weak, as the case may be. In life, it is his individual differences that mark him for success or failure, but in school these must be ignored and blighted. "Every one is best trained for his greatest usefulness in life by destroying his individual differences, by putting him through the same intellectual mill with every one else"; so says the idol of uniformity.

The absurdity of this idea in general needs not to be expanded here. It has

been recognized, and efforts have been made to suppress it as far as programs of study go. Thus there are the classical courses, the scientific courses, the technical courses, each of which is supposed to minister to a definite type of mind. But here again the idol has but been broken into smaller pieces, each fashioned after the form of the whole. This arrangement has again proven unsatisfactory, and the elective system has done much to shatter it. A perfectly rigid course is found at present only in highly specialized professional schools.

But the idol of uniformity still persists in the specifications of each single course. It is manifestly so great an administrative convenience to have a unit of physics mean the same thing—at least superficially—whether the work is done in Florida or in Oregon. So the idol has been shattered into still smaller fragments and each of these, fashioned in the likeness of the original, sits enthroned in some class-room. In this diminutive, unobtrusive, almost unnoticed form, the idol still holds sway over the greater part of the work of the schools. We have become so used to him that we do not recognize the fact that he sits between us and our goal, and effectively prevents our bringing about the long-sought union between education and life.

Is it any less absurd to suppose that every class in physics can be taught successfully in one set way, than it is to imagine that every mind can be trained successfully by the same grind or every malady cured by the same treatment? The experiences in the lives of the children of New York City and of those in Urbana are very different. Can one and the same physics be doled out to both with any hope of bringing physics close to the daily lives of both? Certainly not; any more than you can grow oranges and bananas at the North Pole. Then why do teachers usually take great pride in the nearness with which their course coincides with the standardized forms set up by social convention in defiance of the natural processes of the youthful mind? Were it not far better to take pride in the close adaptation of a course to the needs of the environment in which it is given? Hence the first essential for bringing physics close to the daily life is that the teachers free themselves from the servitude of this idol of uniformity. We must become iconoclasts long enough to smash these diminutive images into fragments.

The *credo* of the idol of uniformity is the syllabus. Strange as it may seem, there are numerous syllabi, all claiming to be authentic. When not enforced by some *pontifex maximus* of the idol of uniformity, these syllabi are fairly harmless. Their chief danger lies in the fact that they tend to focus the attention of teachers on subject matter. In this the syllabus is a just possession of the idol of uniformity, since the latter is only an image, possessing, it is true, the form of a man, but devoid of life, of soul, of spirit. Therefore following the precepts of a syllabus gives a merely superficial uniformity—it creates an external resemblance among physics courses, but does not necessarily assure them an inner similarity, a spirit of investigation, clear judgment, scientific imagination, or unity. In the matter of bringing education close to life, syllabi are as useless as the idol that inspired them.

Once we have freed our minds from the obsession of the idol of uniformity, we are ready to advance to the organization of a course of study that will have some chance of bringing physics and the daily life of the pupils who are to pursue it into close union. It is, however, useless to make outlines until we are well rid of the idol. Assuming that this has been accomplished,

there is one characteristic of the course which is of the most fundamental importance for the purpose in hand, and this is what may be called the philosophy of the course. This determines the point of view or general attitude toward the subject and also settles the method of presentation. Taken as a whole, the philosophy determines the value of the course as a contribution to the mental development of the pupils. If this philosophy is of the right sort, the choice of subject matter is of secondary importance; for then physics enters into the pupil's life as an integral part and creates an attitude toward science and an ability to solve problems scientifically. This attitude and this ability once secured, the pupil will be able to read and experiment intelligently for himself and so to extend his knowledge of the subject as occasion may require. We will try to define this philosophy in such a way that teachers may be helped in discriminating between a weak course and one likely to be of great strength in uniting education with life.

The idea that there is such a thing as the philosophy of a course of study is probably new to most schoolmen, because syllabi and college entrance requirements have so accustomed us to look only at the external form or index of subject matter as defining the excellence of a course that we have failed to notice its far more important internal organization. For the sake of making clear what is meant by the philosophy of a course, and in the hope of attracting your attention to this most fundamentally weighty problem, three types of philosophy of physics courses will be briefly outlined.

The first is the old stand-by which was expressed in the college-entrance statement that physics should teach the "laws and principles of elementary physics." With this end in view, the topics demanded by the college syllabus were sorted out under the heads Mechanics, Heat, Sound, Light and Electricity. The topics that fell under each head were then arranged in what adult teachers considered their order of simplicity. Thus in mechanics, the order was: Centimeter, Gram, Second. These were duly defined without giving the pupil any clue as to what he was to do with them. These simple elements were then compounded in various ways into meters, square centimeters, centimeters per second, grams per cubic centimeter, and so on. The distinction between mass and weight was always carefully made, and each item was carefully memorized so as to be available at the next examination.

In electricity, in like manner, we must begin with the electric charge obtained by rubbing a glass rod with the skin of an unfortunate cat—obscure and pitiful victim of science! Then followed the action of two charges on each other, with descriptions of the various stunts which the two charges could be made to perform—how they could be imprisoned and released, multiplied, divided or annihilated, as the case might be. In all of this the topics were merely described and experiments presented which might serve to illustrate them and make them concrete.

This organization of the course is generally called the "logical" order because it proceeds from what is to the adult physicist simple to what is to him complex. The philosophy back of it may be called the encyclopedic philosophy. In this type of instruction there is usually little unity, no repetition and no problems that are real to the pupils. The victims usually gained from it a hodge-podge of jumbled memories, a few catch phrases which they could not use rationally, and no ability in solving scientifically the real problems of their daily lives.

This method of teaching was dominant in physics courses from about 1890 to 1905. During this period physics justly became one of the most unpopular subjects in the high-school curriculum. Since 1905 its influence has rapidly declined for two reasons: namely, first, it overreached itself by so increasing the number of topics included in the course that it became impossible for the pupils to make even a faint pretense of memorizing them all; and second, the physics teachers themselves came to realize its inadequacy and arose in revolt and overthrew it.

The chief reasons for its inadequacy were these: (1) It gave no unity to the course, since it failed to group the topics about the great principles of physics but contented itself with the superficial classification of subjects under the heads mechanics, heat, and so on. On this account, it gave little chance for the repetition which is so necessary for the successful mastery of a subject. It also furnished little perspective among the large range of topics treated. Artesian wells seemed to the learner as important as the principle of action and reaction. (2) It took slight account of the daily lives of the pupils. Physics was a "disciplinary" subject, forsooth, like mathematics and Latin, and the more distasteful it was to the pupils the greater the benefit derived from it. (3) It conceived the mission of physics to be didactic—to teach the pupils the last word on each topic—rather than to help them to solve problems of their own making. Principles and facts were merely stated, explained, illustrated with strange experiments, and applied to utterly abstract problems like finding the number of dynes that would give a mass of ten grams an acceleration of ten centimeters per second. On this account it failed to appeal to the pupils, so that they were not motivated to act on their own initiatives.

Fortunately for the children, this encyclopedic philosophy has been, as stated, rapidly declining in influence since about 1905. There are at present two other philosophies, very different from each other, which are striving to replace it. The physics teacher must choose between these two, since he can not adopt both. The first of these is not so very different from the older one. Its motto may be expressed in the words: "The first course should give the pupils a general survey of the whole field of physics." In accordance with this motto, it advocates including in the first course something of everything, thereby retaining the old fallacy of too many topics. It, however, seeks to unify the topics by stringing them on the large theories and hypotheses of physics. Thus, the pressure of gases, evaporation, expansion by heat and electrolysis are not isolated phenomena, but are nothing but the results which the normal actions of molecules and atoms would, of course, produce. The phenomena of light do not consist of the familiar facts of vision, but are evidently and simply the effects which any one would expect electromagnetic undulations in an imponderable luminiferous ether to produce. The pupils need not learn clearly and definitely what light actually does in their daily lives, but rather must master the mechanisms which genial physicists have constructed to aid them in picturing how these effects might be brought about.

In this method the daily lives of the pupils plays a relatively subordinate part. Familiar experiences are introduced after the clever mechanisms of the wily physicists have been duly set forth. For example, all matter consists of molecules in motion. When a dish of water stands on the table, the molecules of water under the surface are more crowded together than those above the surface. At the surface

water molecules are flying off into the air and back from the air into the water. But under these conditions more molecules fly from water into air than the reverse; hence the water gradually disappears from the dish. Heat is nothing but molecular kinetic energy. If the water is heated, evidently the kinetic energy of the water molecules is increased. They therefore disappear into the air more rapidly than before, and the dish dries up more quickly. If a bell jar be placed over the dish of water, the molecules of water can not spread over the entire room, but are constrained to butt their heads against the jar. We should expect these impacts to produce a pressure on the inner walls of the jar. After a time a condition is reached in which just as many molecules fly from the water into the air as fly from the air into the water. Then evaporation should cease. We find that it does so. Under these conditions the water vapor in the jar is said to be saturated.

This second method of teaching thus seeks to interpret phenomena to beginners not in terms of immediate concepts like wet, dry, pounds, inches, pressure and the like, but in terms of less immediate abstract concepts like molecules, atom, imponderable ether, and so on. Here, again, the effort is made to impress on the pupils conceptions and interpretations which may be wholly concrete to specialists in physics, but which are totally abstract to beginners, especially those of school age. For this reason this type may be called the theoretical or abstract method.

It will be noted that this theoretical or abstract method has much in common with the encyclopedic philosophy, especially as regards method of presenting topics. It is of necessity didactic in spirit, since it proposes to impose on the pupils, not the laws and principles of physics, but a survey of the whole field, consisting in the last analysis of the theories and working hypotheses of physics. It, therefore, does not encourage originality, initiative and creative imagination, since the system which it seeks to implant has already been worked out by the masters and is so comprehensive that the pupils have to be crowded in order to cover it all in the allotted time. The pupils are thus very apt to pick up the terminology of the system long before the terms stand for anything really concrete to them and they use this terminology freely to cover up their real ignorance of how best to control the forces of nature under a given set of real conditions.

In the courses of this type you will seldom find a topic introduced by a daily experience or by a problem that arises from daily experience. These, to the pupils real and concrete things, are usually placed last under the head of applications. You will often find in these courses topics introduced by laboratory or lecture experiments; but most of these are, for beginners, little less abstract than the dynes, atoms and unit poles into which they are deftly resolved by the teacher. A thing is not concrete to a pupil merely because it is made of matter; it is concrete only when it easily associates itself with the concepts and ideas already present in his mind as the result of his previous experiences.

The abstract philosophy has developed courses that are better organized than the older courses, in that they possess greater unity. They suffer, nevertheless, from many of the faults of the former because they overemphasize the value of physical theory to beginners, and so seek to impose a ready-made system on the pupils without justifying this procedure in advance. Whatever advantages this method may be supposed to have in preparing pupils for later work in some colleges and technical

schools, the over-emphasis of physical theory carries with it an under-emphasis of the daily experiences, and this renders courses of this type little adapted to bringing physics close to daily life. Those who adopt this philosophy may not expect to contribute much to the solution of the problem before us. Their work but adds weight to the demands of that vast majority of our people who must earn their livelihood by controlling the forces of their physical surroundings and solving life's practical problems in the most scientific way.

The other philosophy which is now contending with the abstract for a controlling voice in the organization of physics courses for beginners is quite different from that just discussed. This third system places neither the laws and principles of physics, nor yet the theories and hypotheses of the science at the center of its system. Instead of these human interpretations of phenomena, it centers its ideas about the development to the utmost of the powers and latent abilities of that hope of the future of our nation, the human child himself. It holds that physics does not exist in the schools for the purpose of familiarizing young people with either the laws or the theories of physics; but rather for the sake of helping the pupils to increase their powers of controlling their physical environment intelligently and solving their life's problems rationally. If this help is wisely given, they will, of course, learn the most fundamental facts and generalizations of physics; and they will learn them not as theoretical mechanisms which may help them to imagine how phenomena might be "explained," but as practical knowledge which will help them to control the forces of nature in daily life. Because of the nature of its central idea, this type may be called the practical or concrete philosophy.

This concrete philosophy demands a very different method of treatment from that developed by the other two. The most important differences consist in introducing each topic by means of daily experiences of the pupils of each class, in discussing these topics at the outset by the methods of reasoning with which the pupils are already familiar, in working in both class room and laboratory with materials and apparatus which are in common use outside of physics classes, and in leading to conclusions which are expressed in concrete terms, like pounds and feet, rather than in abstract terms, like atoms and ether.

This method thus takes the child as he is, and seeks to enlarge his fund of information concerning what the things about him will actually do, and to increase his powers of controlling his physical surroundings. Signs and symbols are not introduced until a need for them has arisen and the ideas for which they stand have become fairly concrete by wide association with previous concrete ideas. Theories are not expounded until the pupils have acquired a broad and definite knowledge of the facts and laws which the theories are invented to explain.

The concrete philosophy thus demands an arrangement which begins where that required by the others ends, namely, with the daily life; and ends where the others would begin, with the laws and theories of physics. It lays great weight on having the pupils at the beginning of their course work much with familiar things in ways familiar to them, and insists on their solving many problems of their own making by experiments with apparatus and machines of the sort used in the world's work. It seeks to lead the pupils gradually from the crude intellectual manners with which they come to the physics classes to the more refined and rigorous methods of think-

ing with which they should leave them, at the same time gradually increasing their fund of concrete, definite, dependable and useful information.

This method makes it possible to master fewer principles in a given time; but, as the psychologists have conclusively proved, assures the pupils of a much greater chance of retaining both the subject matter studied and the methods of reasoning used as real helps in solving the real problems of later life. In other words, the method demanded by the practical philosophy is the one that assures us of giving the greatest amount of transferable training.[3]

In order to fix in mind the differences among the three types of method just described, the following three samples of treatment are given. They are typical of the way in which the subject of light may be introduced in accordance with the three types of physical philosophy.

I. *Encyclopedic.*—A luminous body is one that emits light. A medium is any substance through which light passes. A transparent body is one that obstructs light so little that we can see objects through it. A translucent body is one that lets some light pass, but not enough to render objects visible through it. An opaque body is one that does not transmit light. A ray of light is a single line of light. A pencil or beam of light is a collection of rays, which may be parallel, diverging or converging; it may be traced in a dark room into which a sunbeam is admitted by the floating particles of dust which reflect the light to the eye.

The visual angle is the angle formed at the eye by rays coming from the extremities of an object. Knowing the distance of a body, we immediately estimate its size by the visual angle.

Laws of Light. (1) Light passes off from a luminous body equally in all directions. (2) Light travels through a uniform medium in straight lines. (3) The intensity of light decreases as the square of the distance increases.

II. *Abstract.*—Just as sound is defined as undulations in the air, or some other medium, that produce the sensation we call sound, so light, in the same sense, consists of undulations or waves in a medium that produce the sensation called light. Physicists have agreed to call this medium which transmits light the ether. It exists everywhere, even penetrating between the molecules and atoms of ordinary matter. Nothing is known about its nature and but little concerning the exact way in which light travels through it; but the masters of science generally agree that light is a wave motion in the ether, and that the vibrations of these waves are not longitudinal as in sound waves, but transverse. The transverse disturbances by means of which the waves are propagated are probably not transverse physical movements of the ether, but transverse alterations in its electrical and magnetic conditions.

A transparent body is one which allows light to pass through it with so little loss that objects can easily be distinguished through it. Examples of transparent bodies are glass, air, water. A body is translucent when it transmits light so imperfectly that objects can not be seen distinctly through it. Such bodies are horn, oiled paper, thin sheets of wood. Opaque bodies are those which transmit no light, as brick, pig iron, wooden boards. No sharp line of separation between these classes can be drawn; the classification is one of degree.

III. *Concrete.*—If a number of people

[3] For a more detailed discussion of this point, see Mann, "The Teaching of Physics for Purposes of General Education," Chap. VII.–X. New York, Macmillan, 1912.

are asked how large the moon looks, each will give a different answer. One may say that it looks as large as a dime, another that it seems as large as a saucer, while a third may say that it looks as large as a cart wheel. Then, too, the moon looks larger to every one when it is near the horizon than when it is high in the sky.

Infants reach for the moon and cry because they can not get it. Landsmen find it very difficult to estimate the distance between two boats at sea. On the other hand, when we look at a man climbing a distant hill, he appears as but a small speck on the landscape, yet we estimate his size correctly. We even use our knowledge of the man's size to estimate the distance or actual size of the hill or the height of the trees there. Ability to estimate distances and sizes from the way things look is obtained from long practise. Let us see if we can find the reasons for these things.

When sunlight streams through the window, it traces an outline of the window on the floor. If you hold your open hand so that the sunlight falls vertically upon it, the outline of the shadow cast on the floor resembles the outline of the hand. Most of us have amused ourselves making shadow pictures, by so placing the hands between a lamp and the wall that the shadow on the wall resembled a rabbit, a goose, a clown, or any other creature. We might draw the same outline by pivoting one end of a long straight pencil at the source of light, and moving it around the edges of the object, while the other end marked on a paper suitably placed. We can think of such a pencil as if it were the beam from a tiny searchlight moving about the edges of the object and tracing the outline.

When a sunbeam is allowed to enter a darkened room through a small opening, its path, as revealed by the dust particles in the air, is seen to be a straight line. Where it falls on some object it makes a bright spot. The sun, the opening, and the bright spot all lie on the same straight line; so from inside the darkened room we can determine the direction of the sun with reference to objects in the room, by means of the line drawn from the center of the bright spot through the center of the opening. Because light travels in straight lines, we judge the direction of an object by observing the direction in which light from the object travels.

Whatever you may think of the relative merits of the three types of method just outlined, it is clear that the only way to bring physics close to daily life is to bring daily life close to physics. The only method that assures the teacher of doing this successfully is that of the practical or concrete philosophy. It is possible that other methods may be more successful when the aim is to prepare students to meet past or present college entrance requirements, or to pursue later courses in some of the technical schools. Other methods can not, however, compete with the concrete method when the aim of the teaching is the union of education and life. Each teacher must, therefore, choose his own aim and adapt his methods to suit it. Let me in closing remind you of the importance of the choice. Had education and life been united long ago, the schools would not now stand discredited, nor would the demand for separate vocational schools have arisen. A union now of education and life will save the situation.

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ON THE APPEARANCE OF HELIUM AND NEON IN VACUUM TUBES[1]

At the last meeting of the Chemical Society, Sir William Ramsay, Prof. Collie,

[1] From *Nature*.

and Mr. Patterson described some experiments which they regard as proving the transmutation of other elements into helium and neon. I have been making experiments of a somewhat similar character for some time, and though the investigation is not yet finished, the results I have obtained up to the present time seem to me in favor of a different explanation from that put forward at the Chemical Society. I described some of these experiments in a lecture at the Royal Institution on January 17, but as the separate copies of that lecture have not yet been issued, I will give here an account of some of the experiments which seem to me to have the most direct bearing on the phenomenon in question.

I used the method of positive rays to detect the gases; this method is more sensitive than spectrum analysis, and furnishes much more definite information. I may say that the primary object of my experiments was to investigate the origin and properties of a new gas of atomic weight 3, which I shall call X_3, which I discovered by the positive-ray method. This gas, as well as one with an atomic weight 20 (neon?), has appeared sporadically on the photographs taken in the course of the last two years; the discharge in the tube being the ordinary discharge produced by an induction coil through a large bulb furnished with aluminium terminals, and containing gas at a very low pressure. There seems to be no obvious connection between the appearance of either of these lines and the nature of the gas used to fill the tube; the 3 line has appeared when the bulb was filled with hydrogen, with nitrogen, with air, with helium, or with mixtures of hydrogen and oxygen in various proportions; the 20 line when the bulb contained hydrogen, nitrogen, air, hydrochloric acid gas, mixtures of hydrogen and oxygen.

The experiments I made had for their object the discovery of the circumstances which favor the production of X_3, and to test whether it was triatomic hydrogen produced by the discharge, as this is the alternative to its being a new element. I have found that the conditions which lead to a considerable production of X_3 generally give rise to the appearance of helium and neon. Indeed, in the great majority of cases in which I have observed the appearance of traces of helium and neon these gases have been accompanied by larger quantities of X_3; this gas seems to have escaped the notice of the readers of the paper at the Chemical Society. I may mention, too, that along with neon of atomic weight 20 there is a line in these circumstances corresponding to an atomic weight 10 or thereabouts. Though this is probably due to neon with two charges of electricity, it is generally brighter in comparison with the neon line than is usual for the lines corresponding to doubly and singly charged atoms, so that it is not impossible, though perhaps unlikely, that it may be due to a new gas.

The positive rays for the analysis of the gases were produced in a vessel containing gases at a low pressure. I shall call this the testing vessel; the vessel in which the various processes for generating X_3 were tried (the experimenting chamber) was sealed on to the testing vessel, but separated from it by a tap. Thus the pressure in the experimenting chamber was not restricted to being the same as that in the testing vessel, but might have the value which seemed most appropriate for any particular type of experiment. After these experiments were over, the tap was turned and some of the gases from the experimenting chamber let into the testing vessel; a photograph was then taken, and by comparing it with one taken before turning the

tap the new gases present in the experiment chamber could be detected. The processes by which I have hitherto got the most plentiful supply of X_3 are:

(1) By bombarding with kathode rays metals and other bodies.

(2) By the discharge from a Wehnelt kathode through a gas at a low pressure.

(3) By an arc discharge in a gas at a comparatively high pressure.

By far the larger number of the experiments were made by bombarding metals, but I will begin by describing an experiment with the arc, as it raises the question of the origin of these lines in a very direct way. An arc between iron wires passed through hydrogen at about 3 cm. pressure (in this case all the kathode rays would be absorbed quite close to the electrode) for an hour or so, and the gases liberated in the experimenting chamber tested; X_3, helium, and neon were found. The experiment, using the same wires for terminals, was repeated the next day; the three gases were again found. On the next day, still using the same wires, the arc was passed through oxygen; the X_3 line was still there, though much fainter than before; the helium and neon could not be detected with certainty. The next day, using the same terminals, the arc was again passed through oxygen; not one of the lines could be detected. This looks as if these substances were produced by the arc passing through hydrogen. It was found, however, that, still keeping to the same terminals, on pumping the oxygen carefully out and filling up again with hydrogen, the arc through the hydrogen now did not give even a trace of these lines. On replacing the old iron wires by new ones, and sending the arc through the hydrogen, the lines reappeared. This experiment seems to me to point very clearly to the conclusion that these gases were in the terminals to begin with, were removed from them by the long-continued sparking, and were not produced *de novo* by the arc.

In the experiments when the discharge was produced in a tube with a Wehnelt kathode, the potential difference between the terminals was only 220 volts, so that the kathode rays in the tube had only a fraction of the energy they had when the discharge was produced by an induction coil; X_3 and helium appeared when the discharge passed through this tube. I did not detect any neon.

The method which gave X_3 and also the other gases, in the greatest abundance, was to bombard metals, or indeed almost any substance, with kathode rays. The tube used for this purpose had a curved kathode, which focused the rays on a table on which the substance to be bombarded was placed. The substance, round the spot struck by the rays, was generally raised to a bright red heat by the bombardment; the bombardment was as a rule continued for five or six hours at a time. I have got the X_3 line, as a rule, accompanied at first by the helium line, and somewhat less frequently by the neon line, when these following substances (which include nearly all I have tried) were bombarded: iron, nickel, oxide of nickel, zinc, copper, various samples of lead, platinum, two meteorites, and a specimen of black mica given me by Sir James Dewar, which was remarkable for the amount of neon it gave off.

The most abundant supply of X_3 came from platinum, and I will describe an experiment with this metal. A piece of platinum foil was bombarded on four days, and the gases produced each day examined. At the end of the first day's bombardment it was found that the line due to X_3 was very strong, those due to helium and neon weaker, but still quite conspicuous. The gases produced the first day were well

washed out of the tube, and the foil bombarded for a second day. The gases formed proved to be much the same as on the first day; there was no appreciable diminution. The examination of the result of the third day's bombardment showed that the X_3 line had diminished considerably, the lines due to helium and neon perceptibly. When the gases produced on the fourth day's bombardment were examined it was found that the X_3 and helium had diminished to such an extent that the lines were barely visible. I could not see the neon line at all. In this case the helium was not eliminated until the fourth day. In general I have found that the helium disappeared long before the X_3 gas. Thus a piece of old lead I bombarded gave off appreciable quantities of helium from the first day's bombardment, very little on the second day, and none that I could detect on the third or subsequent days. The X_3, on the other hand, came off in considerable quantities up to the end of the experiment, which lasted for six days. I attribute the superior elimination of X_3 in the case of the platinum foil to the fact that during the whole time the bombardment was concentrated on a patch only about 2 mm. in diameter, while the lead melted under the bombardment, so that fresh portions were continually being exposed to the rays. A piece of Kahlbaum's chemically pure lead gave appreciable amounts of X_3 and helium, though not nearly so much as the old lead. I tried some lead which had just been precipitated, but could not detect either X_3 or helium.

In the course of the experiments with old lead I let hydrogen into the experimenting chamber to see if it would increase the amount of X_3, but could not detect any effect. On one occasion I let in oxygen when nickel was bombarded, also without any appreciable effect. I think these experiments are in favor of the view that these gases are present in the metal independently of the bombardment, and are liberated by the action of the kathode rays. They are surprisingly firmly held by the metal, and can not, so far as my experience goes, be got rid of by heating. I kept a piece of lead in a quartz tube boiling in a vacuum for three or four hours, until all but a quarter of the lead had boiled away, and examined the gases given off during this process; neither X_3 nor helium could be detected. I then took the quarter that remained and bombarded it, and got appreciable amounts of X_3 and helium. On a second bombardment the X_3 was visible but the helium had disappeared. As an instance of the way these gases can stick to metals even when in solution or chemical combination, I may mention that though, as I have said, platinum foil after long exposure to kathode rays is freed from these gases, yet I got appreciable quantities of X_3 and helium, though no neon from platinum sponge freshly prepared from platinic chloride.

The reason helium is obtained by heating the glass of old Röntgen-ray bulbs is, I think, that after liberation by the kathode rays, the helium either adheres to the surface or is absorbed in a much looser way than before it was liberated. The question as to how these gases get into the metals is a most interesting one; are they absorbed in the process of manufacture? In this connection it is interesting to note that X_3 does not appear to occur to any appreciable extent in the atmosphere. Sometimes when suffering from the difficulty of clearing out these gases I have been goaded into speculating whether they do not represent the partially abortive attempts of ordinary metals to imitate the behavior of radio-active substance; but whereas in these substances the α particles and the like are emitted with such velocity

that they get clear away from the atom, in ordinary metals they have not sufficient energy to get clear, but cling to the outer parts of the atom, and have to be helped by the kathode rays to escape.

I would like to direct attention to the analogy between the effects just described and an everyday experience with discharge tubes—I mean the difficulty of getting these tubes free from hydrogen when the test is made by a sensitive method like that of the positive rays. Though you may heat the glass of the tube to melting point, may dry the gases by liquid air or cooled charcoal, and free the gases you let into the tube as carefully as you will from hydrogen, you will still get the hydrogen lines by the positive-ray method, even when the bulb has been running several hours a day for nearly a year. The only exception is when oxygen is kept continuously running through the tube, and this, I think, is due, not to lack of liberation of hydrogen, but to the oxygen combining with the small quantity of hydrogen liberated, just as it combines with the mercury vapor and causes the disappearance of the mercury lines. I think this production of hydrogen in the tube is quite analogous to the production of X_3, of helium, and of neon. I have been greatly assisted in the experiments I have described by Mr. F. W. Aston, Trinity College, and Mr. E. Everett.

J. J. Thomson

February 8

THE SMITHSONIAN AFRICAN EXPEDITION

The collections made by the Smithsonian African Expedition under the leadership of Col. Theodore Roosevelt, when received, were distributed to the various departments of the National Museum to which they pertained; the birds were sent to the bird department, the large animals to the mammal department, the plants to the botanical department, and so on. A number of groups of the large mammals have been prepared, and a number of individual specimens mounted for exhibition purposes. Most of the specimens have been placed in the study series, and the duplicates will be distributed by exchange or otherwise.

The groups of large mammals now mounted will shortly be placed on exhibition in the new Museum mammal hall where the larger animals will be exhibited. Those that were on exhibition have been temporarily withdrawn, in order to place them in their proper place in the classification in the hall, which is closed temporarily pending the arrangement of the cases containing the specimens.

It now seems an opportune time to make a final statement relating to the expedition and with this in view the secretary recently communicated with the parties who contributed to the fund, and has thus far received replies from the following that they have no objection to their names being given to the public. In this connection the secretary wishes to state that up to this week Colonel Roosevelt has not known who the contributors were, with the exception of Mr. Carnegie and possibly one or two personal friends.

It has not been the custom of the institution to publish the names of contributors to research work or expeditions conducted under its direction until such enterprise had been completed, and only then when the contributor had no objection to such publication. The contributors include:

Mr. Edward D. Adams, of New York City.
Hon. Robert Bacon, of Boston, Mass.
Mr. Cornelius N. Bliss, of New York.
Mr. James Campbell, of St. Louis, Mo.
Mr. W. Bayard Cutting, of New York City.
Mr. Andrew Carnegie, of New York City.
Mr. Cleveland H. Dodge, of New York City.
Mr. E. H. Gary, of New York City.
Mr. John Hays Hammond, of Washington, D. C.
Col. H. L. Higginson, of Boston, Mass.
Mr. Hennen Jennings, of Washington, D. C.
Mr. J. S. Kennedy, of New York.
Mr. Ralph King, of Cleveland, Ohio.
Hon. George von L. Meyer, of Washington, D. C.
Mr. D. O. Mills, of New York.

Hon. T. H. Newberry, of Michigan.
Mr. L. L. Nunn, of Provo, Utah.
Mr. H. C. Perkins, of Washington, D. C.
Mr. George W. Perkins, of New York City.
Mr. Henry Phipps, of New York City.
Mrs. Whitelaw Reid, of New York City.
Hon. Elihu Root, of Washington, D. C.
Mr. J. C. Rosengarten, of Philadelphia, Pa.
Mr. Jacob H. Schiff, of New York City.
Mr. Isaac N. Seligman, of New York City.
Mr. O. M. Stafford, of Cleveland, Ohio.
Hon. Oscar S. Straus, of New York City.
Mr. Isidor Straus, of New York.

From the contributions, the Smithsonian's three fifths share of all the expenses were paid; the other two fifths were paid by Colonel Roosevelt, which covered all his personal expenses and those of his son, and their proportionate two fifths share of the total expenses of the expedition.

The following is the complete list of the collections made by the expedition that have been received by the institution:

	Specimens
Mammals	5,013
Birds	4,453
Birds' eggs and nests	131
Reptiles and batrachians	2,322
Fish	447
Plants	5,153 sheets
Insects	3,500
Shells	1,500
Miscellaneous invertebrates	650
Total	23,169

As the result of this expedition, the biological collections now in the National Museum from East Africa are probably the most complete and systematic of any in the world.

THE INSTITUTE OF ARTS AND SCIENCES OF COLUMBIA UNIVERSITY

NEW YORK is to have an Institute of Arts and Sciences, which has been organized by Columbia University, to begin operation next fall. The object of the university is to offer its educational advantages to a wider constituency, including professional business men and women, and people of leisure, and to bring the general public into closer relation with its work and purposes. To this end it has been decided to offer, in the late afternoons and evenings, approximately from October to May, short series of lectures, of the university extension type, on history, literature, art, music, drama, ethics, etc., addresses by distinguished statesmen and educators from home and abroad, illustrated lectures on travel, lecture recitals on forthcoming opera, orchestral programs, the history of music, etc., dramatic readings and recitals, and occasional dramas, authors' readings, concerts and recitals by orchestras, operatic singers, and other artists, and oratorios and chorus concerts by the Columbia University Festival Chorus.

The work of the institute will be distinct from the regular academic work of the university and will not receive academic credit in any way, its aim being mainly to furnish a platform for the free and unbiased discussion of current social and economic questions, and to afford a thorough program for general culture, in other words, to provide a system of adult education and rational recreation of an educational nature for busy people. The university offers at present many miscellaneous public lectures which are provided for by special endowment or by exchange professorships, and at times the attendance has been so large that thousands have been turned away. All these lectures will be incorporated in the program of the institute. While many of these lectures and events will be held in the auditoriums on the university campus it is likely that a part of the program will be offered at a Harlem center and also at a down town center, and, as the work grows, other centers will be established. It is expected that about 300 lectures and entertainments will be offered during the season by the best lecturers and artists.

While no definite program for the first season can be announced now the institute has assurances of the cooperation of the Philharmonic Society Orchestra, the New York Symphony Society Orchestra under Walter Damrosch, the Kneisel quartet, and many other organizations, while well known soloists will probably be included in the list of entertain-

ments. The entire control of the Institute will be in the hands of Professor James C. Egbert, the Director of Extension Teaching, who will be assisted by Milton J. Davies, who was secretary to President George E. Vincent, of the Chautauquan Institution, and later was supervisor of lectures and concerts for the Brooklyn Institute of Arts and Sciences. He leaves the position of educational director of the Brooklyn Central branch of the Y. M. C. A. The fee for membership in the institute is $10 annually and the first thousand members will not have to pay a registration fee. After that the registration fee of $5 will have to be paid, once only, however. A membership ticket will admit one person to the day lectures during the entire season, and two to the night lectures. For certain of the more costly events on the program, such as special concerts, membership will be given a reduced rate of admission.

SCIENTIFIC NOTES AND NEWS

THE National Academy of Sciences will hold on April 22, 23 and 24, an adjourned meeting to celebrate the semi-centennial anniversary of its foundation. The academy held its first meeting in New York on April 22, 1863. In addition to the American speakers there will be three speakers from Europe. Professor J. C. Kapteyn, of the Astronomical Laboratory of Groningen, Holland, on "The Structure of the Universe"; Professor Arthur Schuster, secretary of the Royal Society of London, on "International Cooperation in Research"; and Professor Theodor Boveri, of Würzburg, on "The Material Basis of Heredity."

THE Oxford University convocation has voted to confer the degree of doctor of science on Dr. Josiah Royce, professor of the history of philosophy at Harvard University, who has been giving a course of lectures at Manchester College, Oxford.

THE University of Calcutta has conferred the degree of doctor of science on Dr. A. R. Forsyth, F.R.S., who has given a course of mathematical lectures at the university.

THE Helmholtz medal of the Berlin Academy of Sciences has been awarded to Professor S. Schwendener, of the Berlin University, for his researches in plant physiology.

AT the annual meeting of the Royal Astronomical Society on February 14, the gold medal of the society was presented to M. Henri Delandre, of the Meudon Solar Observatory. Officers were elected as follows: *President*, Major E. H. Hills, C.M.G., F.R.S.; *Vice-presidents*, Sir W. H. M. Christie (late astronomer royal), Dr. F. W. Dyson, Mr. A. R. Hinks and Professor H. F. Newall. Mr. Knobel was reelected as treasurer. Mr. A. S. Eddington and Mr. A. Fowler were elected secretaries, and Sir David Gill was reelected to the office of foreign secretary.

AT the anniversary meeting of the Geological Society of London officers for the ensuing year were appointed as follows: *President*, Dr. A. Strahan, F.R.S.; *Vice-presidents*, Professor E. J. Garwood, M.A., Mr. R. D. Oldham, F.R.S. Mr. Clement Reid, F.R.S. and Professor W. W. Watts, F.R.S.; *Secretaries*, Dr. A. Smith Woodward, F.R.S. and Mr. H. H. Thomas; *Foreign Secretary*, Sir Archibald Geikie, President R.S.; *Treasurer*, Mr. Bedford McNeill.

THE Franklin Institute, Philadelphia, acting through its committee on science and the arts, recently awarded the Elliott Cresson gold medal, the highest in the gift of the institute, to the following gentlemen:

Charles Proteus Steinmetz, A.M., Ph.D., of Schenectady, New York, in recognition of successful application of analytical method to the solution of numerous problems of first practical importance in the field of electrical engineering.

Emile Berliner, of Washington, D. C., in recognition of important contributions to telephony and to the science and art of sound-reproduction.

Isham Randolph, D.Eng., of Chicago, Ill., in recognition of distinguished achievement in the field of civil engineering.

John William Strutt, Baron Rayleigh, P.C., J.P., D.C.L., LL.D., F.R.S., Hon.C.E., Sc.D., of Witham, Essex, England, in recognition of extended researches of signal importance in physical science.

Sir William Ramsay, K.C.B., LL.D., D.Sc., M.D., Ph.D., F.R.S., F.C.S., of London, England, in recognition of numerous discoveries of far-reaching importance in the science of chemistry.

Emil Fischer, Ph.D., M.D., D.Sc., F.R.S., of Berlin, Germany, in recognition of numerous contributions of fundamental importance to the science of organic and biological chemistry.

THE annual dinner of the Alumni Association of Stevens Institute of Technology, held on February 14 at the Hotel Astor, took the form of a testimonial to Dr. Humphreys on the tenth anniversary of his inauguration as president of Stevens. The regard of the alumni was evidenced by the presentation of a model of the historic Stevens Castle which was recently purchased by the institute.

DR. JAMES LAW, emeritus professor of veterinary medicine at Cornell University, was seventy-five years old on February 13. In the afternoon Acting President Crane and all the members of the faculty of the Veterinary College called upon Dr. Law at his home to congratulate him.

THE senate on February 20 voted to grant permission to Col. W. C. Gorgas of the Isthmian Canal Commission to enter the service of the Republic of Ecuador for the purpose of cleaning up the port of Guayaquil.

IT is announced that the Canadian government will grant Mr. Stefansson the sum of £15,000 towards his expedition into unexplored territory north of the Canadian mainland. Mr. Stefansson will take with him Canadian students with scientific knowledge, and the expedition will be directly under the Canadian Geological Survey. He expects to be absent three winters and four summers.

DR. H. MONMOUTH Smith, since 1902 professor of chemistry at Syracuse University, has accepted a research position in the nutrition laboratory of the Carnegie Institution.

MR. LANCASTER D. BURLING, assistant curator of the division of invertebrate paleontology in the United States National Museum, has resigned to accept the position of invertebrate paleontologist in the Geological Survey of Canada.

MR. ROBERT ANDERSON has resigned as geologist of the United States Geological Survey and will engage in professional work, in partnership with Mr. A. C. Veatch, specializing in the geology of petroleum.

MR. DAVID HOOPER, curator of the Industrial Section of the Indian Museum, Calcutta, has been appointed economic botanist to the Botanical Survey of India.

PROFESSOR BIER, of the University of Berlin, who has been quoted as having spoken favorably of Dr. Friedmann's treatment for tuberculosis, has given out a statement which concludes as follows: "I must therefore publicly protest against the misuse of my name for the recommendation of a remedy of whose effectiveness I have so far no evidence. I hope that this statement may find its way into the foreign press as quickly and as widely as my alleged recommendation of the treatment. It should also relieve me of the burden of constantly answering letters and stating that I have seen as yet no evidence of any unusual curative action of Friedmann's treatment."

A JOINT meeting of the Washington Academy of Sciences and the Philosophical Society of Washington was held on March 1, in the assembly hall of the Cosmos Club, when an address was given by the Right Honorable James Bryce on "The Physical Aspects of Australia and New Zealand."

PROFESSOR EDWIN G. CONKLIN, of Princeton University, will lecture before the Harvey Society at the New York Academy of Medicine on March 8, his subject being, "The Size of Organisms and their Constituent Parts in Relation to Longevity, Senescence and Rejuvenescence."

N. H. DARTON, geologist, Bureau of Mines, gave recently two lectures on applied geology to the advanced geological students at Columbia University. The subjects were "Construction of Structure Maps of Coal Basins" and "Construction of Maps showing Artesian Water Conditions."

PROFESSOR JOHN B. WATSON, of the Johns Hopkins University, is giving at Columbia a course of eight lectures on animal behavior.

The lectures are given on Monday and Tuesday afternoons at four o'clock.

Professor Karl Bezold, of the University of Heidelberg, is lecturing on ancient oriental art at Chicago, Princeton and other universities.

Professor J. F. Kemp, of Columbia University, lectured on the Catskill Aqueduct of New York and the application of geology to great engineering enterprises, at the Pennsylvania State College on February 25. After the lecture a banquet was tendered Dr. Kemp by the Research Club, consisting of the local members of the Sigma Xi.

The forty-fourth annual presidential address was given on February 13 by Albert McCalla, Ph.D., before the State Microscopical Society of Illinois at Chicago, the subject being "Microscopic Research as an aid to Industrial Arts and Allied Sciences."

On February 25 Professor H. H. Turner began a course of three lectures at the Royal Institution on "The Movements of the Stars"; and on Thursday, March 6, Mr. W. B. Hardy delivered the first of two lectures on "Surface Energy." The Friday evening discourse on February 28 was delivered by the Hon. R. J. Strutt on "Active Nitrogen," and on March 7 by Mr. C. T. R. Wilson on "The Photography of the Paths of Particles ejected from Atoms."

Dr. Philip Hanson Hiss, professor of bacteriology in the College of Physicians and Surgeons, Columbia University, the author of important researches on immunity and infectious diseases, died on February 27, aged forty-four years.

Charles W. Hooker, Ph.D., entomologist of the Federal Experiment Station and plant inspector of the Port of Mayaguez, Porto Rico, died on February 12, at the age of thirty, following an attack of appendicitis. Dr. Hooker, who was a graduate of Amherst College in the class of 1906, received his doctor's degree in entomology at the Massachusetts Agricultural College in 1909.

Sir William White, F.R.S., the distinguished naval architect, for many years chief constructor of the British navy, president of the British Association for the Advancement of Science for the next annual meeting, died on February 28, aged sixty-eight years.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of John Fritz, the iron master, his residuary estate amounting to about $150,000 is given to Lehigh University primarily as an endowment fund for the maintenance of the Fritz Engineering and Testing Laboratory. It is also announced that Mr. Charles L. Taylor, of Pittsburgh, has given Lehigh University a gift for a large gymnasium and a stadium.

By the will of the late Mr. C. C. Weld, of Newport, R. I., the Boston Lying-In Hospital receives $125,000, and the Boston Dispensary $100,000, while the residuary estate, valued at nearly $4,000,000, is in case the daughter of the decedent dies without issue, to be divided between the Massachusetts General Hospital and the Massachusetts Institute of Technology.

Plans for the new electrical laboratory of Harvard University, which is to be built between the Jefferson Physical Laboratory and the Peirce Hall, are nearing completion, and it is expected that actual work of construction will begin early in the spring. The building will cost about $60,000 and is an anonymous gift to the university.

Applications for the Kahn Foundation for the Foreign Travel of American Teachers should be handed to the secretary of the foundation, Sub-station 84, New York City. The next fellows will be selected by the trustees early in May and will begin their travels on July 1, 1913. The reports of the first appointees, Professor Francis Daniels, of Wabash College, and Professor J. H. T. McPherson, of the University of Georgia, are now in the printer's hands. Two fellows are at present abroad: Professor Ivan M. Linforth, of the University of California, is about to leave Germany for the Orient; and Professor William E. Kellicott, of Goucher College, is at present in the British Isles and will shortly

leave for France. The fellowships carry with them stipends of $3,000 and no obligations other than that of making a year's trip around the world and the rendering of a report thereon to the trustees.

AN anonymous donor has offered to the University of Cambridge £10,000 towards the endowment of a chair of astrophysics.

THE University of Birmingham having received an offer from the Board of Agriculture of a grant-in-aid, to be expended in carrying on a research department in agricultural zoology, has appointed Professor F. W. Gamble, F.R.S., as director of the new department.

DR. WALLACE W. ATWOOD, associate professor of physiography and general geology in the University of Chicago, has been appointed professor of physiography in Harvard University.

DISCUSSION AND CORRESPONDENCE

CYTOLOGICAL NOMENCLATURE

THE only possible use for a system of nomenclature is to secure accuracy and convenience in its application. So soon as it produces confusion and becomes unwieldy and cumbersome it defeats its purpose. The real reasons for applying a name to an object are to secure its accurate identification and to facilitate description. It is entirely secondary whether this name is descriptive or not. This fact is fully recognized among biologists in establishing the rule of priority, the sole purpose of which is to secure a definite and permanent relation between an object and its name.

Considerations of this sort apparently have no appeal to cytologists, whose nomenclature is accordingly falling into lamentable confusion. This has resulted very largely from an evident desire to make each term descriptive rather than precise. The same object, whose common identity is recognized by every observer, may, in each study, receive a different name because some real, or supposed, characteristic appeals to the describer. The final result of this practise is easily foretold and is even now making itself manifest. The beginner, instead of being able to acquaint himself with the known facts, is obliged to spend a large part of his time in untangling a complicated terminology; and, unless he has the help of some one personally familiar with the varied career of each term employed, is very apt to go astray. Much time and trouble are also expended by the initiated in discussing the relative descriptive values of the names given to the same object.

It should be the purpose of every investigator to make the machinery of his science as simple as possible and to subordinate everything to the main aim of discovery. The reasonable way to accomplish this is to profit by the experiences of workers in other and older fields and to make such applications of general principles as have been found desirable and necessary in actual practise. It is of little moment whether we are endeavoring to discriminate between two organisms or between two structural elements of these organisms—in either case it is necessary for us to designate the contrasted objects by names which apply to them alone. At the same time it very much simplifies the discussion if but a single term is used for each. Systematists have found that the only way to secure this precision is to insist that the first name applied to any kind of organism be its designation, whether descriptive or not. It seems to me that cytologists may well profit by the hard-earned experiences of the taxonomists and avoid the difficulties of an ineffective terminology. Another practise of systematists that is suggestive of simplicity is the use of qualifying prefixes to well-established words where a new term is called for in the discussion of a subgroup. I feel convinced that a recognition by cytologists of these two principles of nomenclature would do much toward reducing the confusion now existing.

There may be some who do not agree with me regarding the subordinate value of the descriptive element in terminology and who would cite the B N A system of anatomists as a support of their view that terms should be descriptive. The conditions confronting the two classes of workers are, however, entirely

different. The anatomists have a very thorough knowledge of their subject so that they may apply descriptive terms with certainty in most cases, and then, again, their major terms are well fixed by long usage and the modifications proposed in the Basle system are in most cases restricted to qualifying terms. Cytologists, on the contrary, have no such familiarity with their subject and there is lacking an agreement regarding the application of even major terms. Undoubtedly the subject of human anatomy forms the best instance of the possibility of the application of descriptive terms, but even here the necessity for their use is definitely denied and provided against by the fourth principle which reads (Barker, B. N. A.):

> The terms shall be simply memory signs, and need lay no claim to description or to speculative interpretation.

It thus appears that in two of the oldest branches of biological science, general taxonomy and human anatomy, the necessity for definiteness of application in terms, to the neglect of descriptive value, has manifested itself. It would certainly seem the part of wisdom for cytologists to avoid the difficulties which will inevitably arise through the practise now prevailing in their science by applying well-tried methods in their nomenclature.

C. E. McClung

University of Pennsylvania

A SUGGESTED CLASSIFICATION OF WRITINGS ON EUGENICS

The following note is published in response to various inquiries as to a schedule for classifying eugenical writings, for bibliographies, libraries, etc. It lends itself to the decimal system of classification, if desired.

Eugenics

0. Philosophy and bearings of; compendia, essays; periodicals, societies, institutions (record offices, laboratories, etc.), methods, history, bibliography, biography.
1. Racial anthropology.
2. Genealogy or family history, eugenic and cacogenic families.
3. Heredity, including mental traits, normal and pathological (see "Trait, Book of the Eugenics Record Office," Bulletin No. 6).
4. Differential selection of mates and its social control.
5. Differential fecundity and its social control.
6. Differential survival and its social control.
7. Migration and its social control.
8. Culture of the innate traits; relations to eugenics of education, religion, and work for social and individual welfare.

C. B. Davenport

Cold Spring Harbor, L. I.,
February 10, 1913

EQUINE PIROPLASMOSIS IN THE CANAL ZONE

To the Editor of Science: I wish to note the occurrence of equine piroplasmosis in the Canal Zone. The parasite closely resembles *Piroplasma caballi* Nuttall, 1910, and differs from *Nuttallia equi* (Laveran) in not displaying "cross forms."

Equine piroplasmosis has, so far as the literature at hand discloses, appeared in only two other localities in America—São Paulo, Brazil, and Venezuela. The infected animal was an American driving horse that had been on the isthmus several years and no doubt became infected from ticks while driven out into Las Sabanas to the Juan Diaz River. The disease is very likely epizootic in the interior of the republic, for native cattlemen speak of a disease of horses there resembling anthrax.

In view of the fact that among animals in the commission corrals, it has been found that horses, from their use on the trails, become infested with ticks, *Dermacentor nitens* chiefly, while the draft mules, from their restricted use on the roads, usually are not infested with ticks; it is interesting to note that piroplasmosis, a tick-transmitted disease, appeared in a tick-infested horse, while murrina, the trypanosomal disease of equines of Panama (fly transmitted) was confined absolutely to draft animals, tick-infested saddle horses

never, under any circumstances, becoming naturally infected.

S. T. DARLING

BOARD OF HEALTH LABORATORY,
ANCON, CANAL ZONE

A REQUEST FROM THE AMERICAN SOCIETY OF NATURALISTS

THE American Society of Naturalists does not possess a complete set of its published "Records." It has no copy of Part IV., Volume II. The secretary wishes to complete at least one set of the "Records" to be deposited with other material at the Wistar Institute.

Several complete sets may be made up if copies of the following can be obtained:

Volume I., Parts II., III., IV., V., VII., VIII., IX. and XI.

Volume II., Parts I., II., IV., V., VI. and VII.

Members of the society are therefore asked to look through their papers and to write to the secretary if they can supply any of the parts desired.

BRADLEY MOORE DAVIS,
Secretary for 1913

UNIVERSITY OF PENNSYLVANIA,
PHILADELPHIA, PA.

THE FACTS ABOUT THE ACCOUNTS OF LEARNED SOCIETIES

TO THE EDITOR OF SCIENCE: The article by Professor Hart in SCIENCE for January 10 contains errors that need correction. The financial report of the American Academy of Political and Social Science for the year 1910 has been compared with the reports of the other societies for 1911, although the Academy's financial statement for 1911 was printed in May, 1912, eight months before Professor Hart's article appeared.

The apparent discrepancy between membership list and paying members is due to the fact that Professor Hart fails to take into account the 128 life members and 503 subscribers of the Academy represented mainly by libraries and other institutions not eligible to membership.

The statement is made in the article that the expenditure of the Academy, per paying member, was $6.71 for the year 1910. This calculation is not based on the true figures for membership, and suppresses the fact that $10,493.00 was received from subscriptions to publications by non-members, from sales of current numbers, from special contributions and from life-membership fees.

The number of pages published during the year 1910 is said to be 1,523 when in fact 2,034 pages were printed. The number of words published in 1910 was 1,176,650 and not 685,000, as stated in the article.

The details are as follows:

37,300 copies of *Annals* issued in 1910.
1,500 copies of *Annals* reprinted.
10,700 copies of a Child Labor supplement.
27,800 copies of four issues of supplements.
9,500 copies of reprints.

The average cost of printing per 1,000 words was $16.37, and not $32.50, but included in this cost are items not directly chargeable to the printing of the *Annals*, as will be seen by the enumeration in the report.

Such are the facts about the American Academy. Professor Hart's statements about the American Historical Association are also incorrect. The proceedings are printed and sent out at government expense, and hence it has no postage bills of this sort in its accounts. The association does not print its own magazine, but has a contract with a publishing house which issues it at a net rate to the members of the association. The receipts for advertising and subscriptions are thus not accounted for in the report of the society, nor does it contain the bills for postage and for clerical help employed by the publishing house. These net costs can not fairly be compared with the gross costs tabulated in the annual report of the American Academy.

SIMON N. PATTEN

IS THE "ACADEMIC COSTUME" WORTH WHILE?

TO THE EDITOR OF SCIENCE: I shall not attempt to answer the above question, raised by Professor Wilder in your issue of January 31. But if the question had been worded "Is

the academic costume worth paying \$35 to \$95 for?" I would quickly answer "No." Considering it desirable to provide myself with a doctor's gown and hood, I purchased the silk and velvet trimming by the yard, and got a dressmaker to make the gown after the pattern of one owned by a friend. As a result I have a first-class gown of the best material, and the cost was about half the regular price of a similar gown ready made.

J.

SCIENTIFIC BOOKS

Michigan Bird Life, a List of the Bird Species known to Occur in the State Together With an Outline of their Classification and an Account of the Life History of Each Species, with Special Reference to its Relation to Agriculture. With seventy-five full page plates and one hundred and fifty-two text figures. By WALTER BRADFORD BARROWS, S.B., Professor of Zoology and Physiology and Curator of the General Museum. Special Bulletin of the Department of Zoology and Physiology of the Michigan Agriculture College. Published by the Michigan Agricultural College. 1912. 8vo. Pp. xiv + 822, 70 half-tone plates and 152 text figures.

The purpose and general character of the present work are stated by the author to be to provide an authoritative list of the birds of Michigan, with such additional information respecting them as would be useful and of interest not only to the nature lover and general reader, but to students and teachers. In a work originating with and published by a State Agricultural College, it is eminently proper that special attention should be given to the economic status of the species in relation to man's interests, yet it is recognized that each has "a scientific, an esthetic, a human value, which can not be estimated in dollars and cents," and which should forever protect it "from extreme persecution, and above all from final extinction."

An introduction of nearly thirty pages deals with the physiographic and climatic features of the state, the distribution of its plant and animal life, and especially its bird life with reference to the different areas characterized by special conditions of environment, as prairies, marshes and pine and hardwood forests. The subject "how to study birds" is discussed at some length, and with intelligence and fairness, the conclusion being that field-glass records of rare species by amateurs should not be relied upon as satisfactory evidences of occurrence. Where there is any improbability of a bird being at a given time and place, the record should "rest upon an actual specimen taken at that locality and either preserved for the examination of any one interested or at least examined and identified by a competent authority before being destroyed."

Nearly ten pages are given to the subject of migration, which includes not only comment on the migratory movements of birds in Michigan, but a summary of recent progress in knowledge of bird migration, remarks on the rapidity of flight in birds, and on the disasters known to overtake birds in migration, by which thousands upon thousands lose their lives through adverse weather conditions, so that large areas become nearly depopulated of certain species. Attention is also called to recent changes in the bird life of Michigan through deforestation of large portions of the state, the draining of marshes, etc., and the consequent increase or decrease of certain species.

The main text of the work treats, in systematic sequence, of the 326 species of birds known to occur in the state, with keys to the species and higher groups, a liberal amount of biographical matter, followed by diagnoses in small type. The life histories are especially full, with often somewhat extended discussion of the economic relations of the species to agriculture, for which the author is especially fitted by his twenty-five years of study of the complex relations of birds to insects and crops as a specialist in this field, first under the United States Department of Agriculture and later at Michigan Agricultural College. A "hypothetical list" of 62 species of birds that have been attributed to Michigan by previous

authors, but whose occurrence there is doubtful, is given in an appendix, where the alleged claims of each to a place in the Michigan fauna are set forth. A bibliography of some twenty-five closely printed pages, a glossary of technical terms, a list of contributors to the work, and an index round out the volume, which will take its place among the best of the state ornithological manuals.

J. A. A.

A School Chemistry. By F. R. L. WILSON, M.A., Assistant Master at Charterhouse, and G. W. HEDLEY, M.A., Head Science Master, Military and Civil Side Cheltenham College. Oxford, H. Frowde. 1912.

This work has been prepared to supply a demand for a shorter course than the author's "Elementary Chemistry." One who has completed the work in a satisfactory manner is prepared to take the matriculation examinations for a number of English universities. The directions for work are very full and the selection and arrangement of experiments are excellent. Wherever possible the experiments are carried out quantitatively and questions and problems are introduced at the end of each chapter. The use of this book by a student should develop his powers of observation and scientific method of reasoning and give him a good insight into the fundamental principles of chemistry.

J. E. G.

Practical Chemistry for Engineering Students. By A. J. HALE, B.Sc. (London), with an introductory note by Professor R. MELDOLA. London, Longmans, Green & Co. 1912. $1.00 net.

In the introductory note attention is called to the fact that while chemistry is recognized as necessary for engineering students, owing to the short time at their disposal for this subject and the lack of appreciation of its value by the students themselves, the course in this subject must be so arranged as to give as much as possible in a short time. In order to get some training in quantitative analysis they must know some general chemistry and qualitative analysis. Although this book is intended primarily for engineering students it is possible, by the selection of certain designated experiments, to use it in connection with a course in the chemistry of building materials. The experiments in general chemistry are well selected to bring out the general principles of the subject, and the experiments are arranged in such a manner as will bring out the quantitative relations whenever possible. This is followed by a short course on qualitative analysis and work in quantitative analysis, the latter being selected to give practise in the preparation of standard solutions, gravimetric and volumetric determinations and methods of analysis of materials of special importance for the engineer, such as water analysis, determinations of the value of fuel, furnace gases, analysis of cements and alloys. While the general method here used would be approved by most chemists, the necessarily limited number of quantitative methods which can be given would no doubt lead to a wide divergence of opinion as to the ones best suited for the purpose.

J. E. G.

Review Questions and Problems in Chemistry. By M. S. H. UNGER, A.M., Head Master, St. John's School, Manlius, N. Y. Ginn & Co. 50 cents.

An excellent manual for use in reviewing classes or formulating examination questions in preparatory school work, covering as it does all the material necessary for college entrance or college board examinations.

J. E. G.

SPECIAL ARTICLES

THE TEMPERATURE COEFFICIENT OF THE COAGULATION CAUSED BY ULTRAVIOLET LIGHT

IT has been pointed out in a previous paper[1] that certain proteins coagulate when exposed to ultraviolet light. In order to learn something about the nature of this reaction it seemed desirable to investigate its temperature coefficient. As photochemical reactions in general are nearly independent of tempera-

[1] SCIENCE, N. S., 37: 24–25, 1913.

ture, it seemed possible that the speed of the coagulation might not be greatly affected by temperature.

In order to test this matter, crystallized egg albumin was prepared by the method of Hopkins and Pinkus. The albumin was recrystallized seven times; the ammonium sulfate was not dialyzed out. A 5 per cent. solution of this albumin was placed in quartz test tubes and exposed to the light from a quartz mercury vapor lamp. The temperature was controlled by keeping the quartz test tubes in water baths automatically maintained at various temperatures and so arranged as to give the tubes equal illumination. The amount of coagulation was estimated by measuring the amount of deposit in the test tubes after centrifuging in sedimentation tubes. The result of these experiments indicated that the temperature coefficient equals or exceeds two.

Of especial interest is the behavior of the tubes which were kept at 0° C. These tubes were still clear after being exposed to the light for 35 hours, while those exposed at higher temperatures contained coagulum. If the tubes which had been exposed at 0° C. were warmed a few degrees their contents began to coagulate. If they were put back into the ice water as soon as the coagulum began to appear the reaction was reversed and the tubes cleared up. This result could be obtained only by cooling the tubes to 0° C. as soon as the coagulum began to appear.

We are dealing here with at least two reactions, first, the change produced by the light, and, second, the production of a visible coagulum.[3] Only the latter has a temperature coefficient as high as two. To demonstrate this it is only necessary to expose tubes at various temperatures for a few hours, turn off the light, remove the tubes from the bath at 0° C. and place them in a warm bath. Although the tubes are perfectly clear when removed from the ice water, a coagulum appears as soon as they begin to warm up. The amount of this coagulum is about the same as if the tubes had been kept in the warm bath during the entire period of exposure to the light. It is therefore evident that the action of the light is about the same at 0° C. as at the higher temperatures. We are apparently justified in concluding that the light produces a substance which promotes coagulation and produces it about as rapidly at the lower temperature as at the higher, but that this substance is unable at 0° C. to bring about any visible coagulation, at least during the time of this experiment. Evidently the temperature coefficient of the light reaction is very low in this case, as is the rule in light reactions. The method of the experiment yielded only approximate results, since the tubes which were kept at 0° C. and which remained clear during the exposure allowed a better penetration of light than those maintained at higher temperatures in which coagulum formed. The highest temperature was only 50° C.

These experiments allow an interpretation of the results of Blackman and Matthei[3] according to whom the process of photosynthesis has a temperature coefficient as high as two. It is of course highly improbable that a photochemical reaction has a temperature coefficient which is so high. It seems much more probable that in photosynthesis, as in the coagulation above described, light acts almost independent of temperature in producing a substance which then undergoes a reaction with other substances, and that it is this latter reaction which has the high temperature coefficient.

The time-temperature curve of the coagulation of proteins by heat has been worked out with great care by Chick and Martin.[4]

[3] *In the presence of certain salts some proteins* in solution may be denatured by heat, but no visible coagulum forms until the salts are dialyzed out. Whether this has any relation to the phenomenon here described can not be discussed at present.

[3] "'Experimental Researches on Vegetable Assimilation and Respiration. III. On the Effect of Temperature on Carbon-dioxide Assimilation,'' *Phil. Trans. Roy. Soc. of London*, B., 197: 47–105, 1904.

[4] "'On the Heat Coagulations of Proteins,'' *Journal of Physiology*, 40: 404, 1910; *ibid.*, 43: 1, 1911.

In order to determine whether the character of this curve is altered by exposing the protein to ultraviolet light experiments were made with egg albumin which had been freed from ammonium sulfate by dialyzing for a long time against tap water. The albumin was exposed at 0° C.: samples were then placed in tubes and heated to various temperatures in a water bath. The tubes were centrifuged and the volume of coagulum estimated. The method gave only approximate results. However, they were consistent, and the differences in the amount of coagulum obtained under the various conditions were so great that it is evident that the temperature-time curve for coagulation, by heat, of egg albumin which has been exposed to the light, is of the same general form as the one given by Chick and Martin. But the curve lies at all points from 10° to 15° C. below the one given by them.

The chief result of these experiments is that two reactions are involved in the coagulation of proteins by light: the chemical change caused by the light, and the production of a visible coagulum. The light reaction has a very low temperature coefficient, while the reaction producing the visible coagulum has a much higher temperature coefficient. It is probable that similar relations exist in other biochemical and physiological processes which result from the action of light.

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THE BOTANICAL SOCIETY OF AMERICA

THE annual meeting of the Botanical Society of America was held in the Chemical Building of Western Reserve University, Cleveland, Ohio, December 31 to January 2, 1913.

The following officers were elected for the ensuing year:

President—D. H. Campbell, Leland Stanford University.

Vice-president—M. A. Howe, New York Botanical Garden.

Treasurer—Arthur Hollick, New York Botanical Garden.

Councilor—George F. Atkinson, Cornell University.

These with R. A. Harper and William Trelease, councilors, and George T. Moore, secretary, constitute the council for 1913.

The following botanists were elected to associate membership: Robert F. Griggs, Ohio State University; Alfred P. Dachnowski, Ohio State University; Warner Jackson Morse, Maine Experiment Station; L. Lancelot Burlingame, Leland Stanford University; John J. Thornber, University of Arizona; James Theophilus Barrett, University of Illinois; Arlow Burdette Stout, New York Botanical Garden; Ezra Brainerd, Middlebury, Vt.; Norman Taylor, curator, Brooklyn Botanic Garden; William Dana Hoyt, fellow by courtesy, Johns Hopkins University; Edward M. Gilbert, University of Wisconsin; Lester Whyland Sharp, Alma, Michigan; William Skinner Cooper, Carmel, California.

A symposium on "Permeability and Osmotic Pressure" was held January 1, participated in by Professors Jacques Loeb, Harry C. Jones, W. J. V. Osterhout and Burton E. Livingston. The papers will be printed in the *Plant World*.

The address of retiring President W. G. Farlow, on "The Change from the Old to the New Botany in the United States,"[1] was delivered at the dinner for all botanists, on the evening of January 1.

Amendments to the constitution, making it possible for all those actively interested in botanical work to become eligible for membership and providing for "fellows," were adopted. The dues for 1913 were made $1.00. Active steps for the publication of a botanical journal by the society were taken.

First Generation Hybrids between Œnothera Lamarckiana and O. cruciata: GEORGE H. SHULL, Carnegie Institution.

Constant Variants of Capsella: HENRI HUS, University of Michigan.

Pedigree cultures from the original individual proved the existence of constant forms, not previously reported. Some of these apparently are not identical with the biotypes previously described by Shull. Emphasis is laid on the importance of the study of seedling stages, since, for purposes of identification, climax leaves may be relied upon under certain conditions only.

[1] SCIENCE, January 17, 1913.

The Problem of the Origin of Œnothera Lamarckiana De Vries: B. M. DAVIS, University of Pennsylvania.

The identification of Lamarck's evening primrose, *Œnothera Lamarckiana* Seringe 1828 (*O. grandiflora* Lamarck †1798), as a form of *Œnothera grandiflora* Solander 1789,[5] has materially changed the situation with respect to the origin of the plant which has been the subject of such extensive experimentation by Professor De Vries. *Œnothera Lamarckiana* Seringe becomes a synonym of *O. grandiflora* Solander and the plant of De Vries's cultures is left without a name or at least without the authority of Seringe. I have proposed in the paper cited above that the name *Lamarckiana* be kept for De Vries's plant and that the name be written *Œnothera Lamarckiana* De Vries. The retention of the old name is justified by the fact that the *Lamarckiana* of De Vries's cultures is not known as a native species in any part of the world and there is good reason for believing that the plant has come down to us as a hybrid and a product of a long period of cultivation. To change the name of this plant made famous by the studies of De Vries would carry endless confusion through the literature of experimental morphology.

Œnothera Lamarckiana De Vries first appeared on the market when introduced by the firm of Carter and Company, seedsmen in London, about 1860. There is evidence from a sheet in the Gray Herbarium[6] that this plant underwent certain modifications during the twenty-five years that elapsed before De Vries began his studies upon *Lamarckiana*. The problem of the origin of *Œnothera Lamarckiana* then centers on the history and composition of the cultures of Carter and Company.

Carter and Company state that they received their seed unnamed from Texas. If this is correct we have reason to hope that thorough exploration in the south and west may bring to light large-flowered œnotheras from which *Lamarckiana* might have been derived either directly or indirectly as a hybrid. American botanists have then the problem of the discovery and isolation by culture of any large-flowered œnotheras in the south and west which might have had a direct relationship to *Lamarckiana* or which might have been one of the parents of a possible cross. The rediscovery of *Œnothera grandiflora* Solander in Alabama was a good beginning in this search, but the search should be pushed further. There is thus a tangible problem of whether or not such forms are or ever were present as native American species. If they were present in Texas in 1860 they may surely be expected there to-day.

The fact that large-flowered œnotheras were established in England as early as 1806 in localities (as the sand hills of Lancashire) which are at present occupied by extensive growths of *Lamarckiana* suggests the possibility that *Lamarckiana* was in England before 1860 and that the cultures of Carter and Company may have come not from Texas but from some part of England, and that their association with a Texan source may have been some mistake on the part of the seedsmen. English botanists have the problem of the history of such *Œnothera* floras as that of the Lancashire sand hills, and collections should be searched with great thoroughness for herbarium sheets that may be of assistance in tracing its development.

With Lamarck's plant, grown in Paris about 1796, identified as a form of *Œnothera grandiflora* Solander there has developed a much clearer situation than formerly when attempts were made to place the time of the introduction into Europe of *O. Lamarckiana* De Vries at various dates previous to 1778, the year when *O. grandiflora* Solander was introduced at Kew. There is then on historical grounds no evidence why *Lamarckiana* De Vries might not have arisen in England after 1778 as a hybrid between forms of *grandiflora* and forms of *biennis*. This is the working hypothesis which is receiving strong support from my experimental studies with hybrids between strains of *biennis* and *grandiflora*.

An exhibit of hybrids between *Œnothera biennis* and *O. grandiflora* that resemble *O. Lamarckiana* De Vries was then discussed.

The Experimental Demonstration of the Validity of the Biological Doctrine of Recapitulation: E. C. JEFFREY, Harvard University.

The Plant Formations of the Nebraska Sandhills: R. J. POOL, University of Nebraska.

The sandhills of Nebraska cover an area of approximately 20,000 square miles, which lies to the north and west of the central portion of the state. The soil of the upland is a straw-colored sand mostly of Tertiary origin. This sand has been blown into innumerable dunes which cover the

[5] See Davis, *Bull. Tor. Bot. Club*, November, 1912.

[6] See Davis, *Amer. Nat.*, XLVI., p. 417, 1912.

underlying rocks of the Arikaree formation with a loose porous soil varying in depth from a few feet to over 150 feet. Wind action is still a pronounced factor in shaping the topography of the uplands, although the region as a whole is practically stabilized by invading vegetation. The influence of wind is reflected most forcibly at present in the regions of active "blow-outs" and "sand-draws."

The greater part of the upland in this great dune region is effectively held against wind erosion by the Bunch-grass Association, a sub-division of the Prairie Grass Formation. Another conspicuous association of the upland is the Blow-out Association. The valleys are characterized by less xerophilous association which in the main are members of the Prairie Grass Formation to the east. The Short Grass Formation has pushed in from the west in a number of places and has occupied especially the hard land in some of the valleys. Forest formations are found along streams and spring branches that are related to the central hardwoods region and to the Rocky Mountain forest region. The streams, wet valleys and numerous lakes reveal the presence of a number of marsh and aquatic associations which are in the main similar to such associations found farther eastward in the Prairie Grass Formation.

The International Phytogeographic Excursion of 1911 and 1913: H. C. COWLES, University of Chicago.

In August, 1911, there was held in the British Isles under the auspices of the British Vegetation Committee the first International Phytogeographic Excursion. A dozen phytogeographers from six different countries were conducted to the places in England, Scotland and Ireland where the natural vegetation is of greatest interest. In all the places visited there were competent British guides, who were very familiar with the vegetational features to be considered. The guiding spirit of the excursion was Dr. A. G. Tansley, of Cambridge, who accompanied the party throughout the tour, and attended to numberless details.

Among the many valuable features of the British excursion were (1) the opportunity of getting intimately acquainted in a short time with the most important features of the British vegetation; (2) the opportunity to know in intimate fashion the British botanists who accompanied the party and who were met from place to place, and to know with special intimacy the foreign colleagues with whom we were associated closely every day for a month; (3) the opportunity to discuss the problems of vegetation as we met them together in the field, and thus without misunderstanding one another and with the certainty that we were talking about the same things.

It was the unanimous opinion of those who participated in the British excursion that the benefits to all were so considerable that similar excursions should be made a permanent feature of International Phytogeography, and at frequent intervals. The second excursion has been definitely announced for the United States in August and September, 1913, and it has been suggested that a third excursion be held on the continent of Europe, immediately after the conclusion of the London Botanical Congress in 1915. It is hoped that American botanists, and especially those interested in the advance of ecology and plant geography, will cooperate in every way possible to make the excursion of 1913 a great success.

Prairie Openings in a Forest Region: B. SHIMEK, Iowa State University.

A prairie opening on the exposed terminus of a ridge near Iowa City, Iowa, has retained its original prairie flora through all the changes incident to the clearing of much of the surrounding country and the building of an electric railway which cuts a part of the ridge.

The distinction between the flora of this area and an adjoining timbered tract is sharply brought out by comparative lists of the plants. The plants of the latter area are broad-leaved, and the leaves present a distinct dorsi-ventral structure, while those of the prairie are narrow-leaved, and the leaves are often more nearly erect or ascending.

A comparison of evaporation and transpiration on the two areas shows that evaporation is much greater on the open surface, but that transpiration may be less.

An artificial opening, created by a road-clearing through the original forest near Homestead, Iowa, more than fifty years ago, is similarly discussed with reference to its flora. The greater part of the area is somewhat sandy, and the road-strip, which is about fifty feet wide, extends almost due north and south through about a mile of forest.

This roadway has been kept clear of larger brush and small trees which occasionally spring up, and as a result a very characteristic prairie flora has taken possession of most of the roadside.

Both areas are discussed with reference to their bearing on the question of the causes of the treelessness of the prairies, and the fact is emphasized

that prairie fires especially could not have been the cause.

Vegetation Features of the Columbus Quadrangle: A. Dachnowski and F. B. H. Brown.

The Genus Helianthus in Southern Michigan: S. Alexander.

This paper involves the recognition of a large number of new forms. An attempt is made to classify sunflowers on the basis of their underground systems and of their venation.

The Regulatory Formation of Tannase in Aspergillus niger and Penicillium sp.: Lewis Knudson, Cornell University.

Aspergillus niger, Penicillium rugulosum and *Penicillium* sp., can ferment tannic (gallotannic) acid, gallic acid resulting. Employing the two organisms *Aspergillus niger* and *Penicillium* sp., the writer made experiments in which a modified Czapek's solution was employed as the nutrient medium. When the source of carbon is tannic acid, gallic acid or cane sugar supplemented by tannic or gallic acids at certain concentrations, these organisms form the enzyme tannase. In the absence of tannic or gallic acids no tannase is formed. In these experiments the effect of each of fourteen other organic compounds was tested, but none could stimulate the formation of the tannase. The gallic acid is not as efficient as the tannic acid in stimulating to formation by these organisms the enzyme tannase.

In certain experiments the influence of concentration of tannic acid on the quantity of the tannase produced was determined. The source of carbon was 10 per cent. sugar supplemented by tannic acid in variable quantities. It was found that the greater the concentration of tannic acid present the greater is the quantity of the enzyme tannase produced. The greatest quantity of enzyme is produced when tannic acid is the sole source of carbon. In other experiments the source of carbon was 2 per cent. tannic acid, and variable quantities of cane sugar employed. It was found that the higher the concentration of cane sugar the less is the quantity of tannase produced.

The Relation of Ventilation to the Respiration of Fruits: George R. Hill, Jr., Missouri Botanical Garden.

A study was made of the respiration and other metabolic phenomena of green and well-ripened fruits which had been placed in nitrogen, hydrogen air and carbon dioxide. Cherries, blackberries, green, market-ripe and very ripe peaches, ripe red Astrachan apples and Concord and Catawba grapes were used. Particular attention was given to an investigation of the common cold storage injury to peaches, "ice-scald," and the results point quite definitely to a close relationship between it and anaerobic respiration. The keeping qualities of the fruits in storage in the gases named, and the relation of these to ventilation, was also considered. The experiments were run in triplicate and the temperature was kept constant by an apparatus devised especially for the purpose.

Conditions Affecting the Development of Lycopin in the Tomato: B. M. Duggar, Missouri Botanical Garden.

Willstätter and Escher have shown that the red pigment of the tomato (lycopin, solanorubin) and carotin (derived from the carrot) are isomeric compounds, readily distinguishable by their physical properties. In the ripening tomato both lycopin and carotin occur. An experimental study of the effects of various conditions upon ripening demonstrates that while carotin is developed under conditions of growth differing widely, lycopin is formed only within a limited range of metabolic activity. Temperature and oxygen supply are two of the factors indirectly limiting lycopin development. In yellow varieties of the tomato "carotin" only is found, and in red varieties lycopin formation is precluded by high temperature, yellow fruits resulting. Irreversible effects are not produced by heat. Red tomatoes seem to contain a factor for redness superimposed upon the factor or factors for yellow, and this conclusion is borne out by breeding experiments.

A Chemical and Physiological Study of After-ripening of the Rosaceæ: Sophia Eckerson.

The Hawthorn is one of the few seeds where there is known to be a dormancy of the embryo. A period of "after-ripening" is necessary before germination is possible. Food is stored in the embryo as a fatty oil. Neither starch nor sugar is present. The reaction of the cotyledons is acid, but the hypocotyl is slightly basic. The water-absorbing power of the hypocotyl is less than 25 per cent. of the wet weight.

There is a series of metabolic changes in the embryo during the period of after-ripening. The initial change seems to be an increased acidity. Correlated with this is an increased water-holding power, and an increase in the activity of catalase and peroxidase. Near the end of the period of after-ripening there is a sudden greater increase in the acidity, and in the water content. All of

these increase until the hypocotyl is 3–5 cm. long. At this time the fats decrease and sugar appears.

The after-ripening period can be shortened greatly by treating the embryos with dilute solutions of HCl, butyric and acetic acids. The water-holding power, the acidity and the activity of peroxidase increase much more rapidly than in the untreated embryos.

The Use of Celloidin Membranes for Demonstration of Osmosis: G. M. SMITH, University of Wisconsin.

The membranes were prepared by pouring a 10 per cent. solution of celloidin on a dish of clean mercury and, after allowing the celloidin to dry sufficiently to be lifted, it was placed over the end of a thistle tube, tied down and allowed to harden. Two membranes were made, one over the other; the double membranes proving themselves ten times as strong as the single ones. The tensile strength of the membrane was found by setting up the osmometer and pouring in mercury and noting the height of the column, when the rupture of the membrane occurred. The double membranes stand over three atmospheres pressure without breaking.

The membranes were rendered semipermeable by putting a M/20 potassium ferrocyanide solution inside of the osmometer and immersing the apparatus in a M/20 copper sulphate solution. A good membrane is formed within the celloidin in three days. When a celloidin membrane separates water and a 3M cane sugar solution the liquid in the osmometer will rise about seven feet in three days and then sink; but when the celloidin membrane contains a copper ferrocyanide precipitate the liquid will rise about twenty-five feet in ten days and then slowly sink.

Studies of Osmotic Pressure: M. A. BRANNON, University of Chicago.

This report is based upon studies made in the plant physiological laboratories at the University of Chicago. The work extended over a period of ten months. The measurements of osmotic pressure were made by cryoscopic methods, the Beckmann apparatus being employed to determine the freezing points of the solutions used.

Three different kinds of potatoes were chosen. They were placed in controlled conditions so that only one limiting factor, heat, was involved in the experiments. One collection of potatoes was placed in an icebox where a temperature of 2° C. was maintained and one collection was kept at a temperature of 25° C.

At the beginning of the experiments the osmotic pressure of the different potatoes was about 7 atmospheres. After ten months the icebox potatoes had developed a maximum osmotic pressure of 13 atmospheres. The lower temperature favored metabolic activities resulting in the liberation of an acid, a catalyte and the fermentation of foods, stored in the form of starch and hemicellulose. The change from colloids to crystalloids was accompanied by the rise in osmotic pressure noted.

The fermentation of the hemicellulose was indicated microscopically by the great reduction in the thickness in the cell walls of the potato tissue affected, and also by the great increase in the brittleness of the potato tissues involved.

These studies are suggestive of the changes taking place in the after ripening of seeds, tubers and bulbs, and has a definite relation to several economic and scientific problems.

Protoplasmic Contractions Resembling Plasmolysis which are caused by Pure Distilled Water: W. J. V. OSTERHOUT, Harvard University.

True plasmolysis can be produced only by solutions which are hypertonic, but appearances almost or quite undistinguishable from it may be brought about by hypotonic solutions. Some light is thrown on the nature of this result by a study of certain cases in which it is caused by pure distilled water. Material for such study is afforded by marine plants.

The root tips of the eel grass (*Zostera marina*) are well adapted to this purpose. The root tips were carefully removed from the sand in which they were growing and immediately placed in sea water.

The application of distilled water causes a contraction of the protoplasm which often closely resembles the true plasmolysis produced by hypertonic sea water (which has been concentrated by evaporation) or by hypertonic sugar solutions. The mode and the degree of contraction vary somewhat, but in general the variations in true plasmolysis are of the same sort, as in what may be conveniently called the false plasmolysis. We may use the term false plasmolysis to designate not only the contraction produced by distilled water, but also that which is caused by certain hypotonic solutions.

The Effect of Anesthetics on Permeability: W. J. V. OSTERHOUT, Harvard University.

Experiments were performed to test the elec-

trical conductivity of living tissues in various solutions. The results show conclusively that a great variety of ions readily penetrate living cells and that this penetration may be markedly hindered or accelerated by the addition of various substances to the solution. The addition of anesthetics, such as ether and chloroform, has a retarding effect on the penetration. It would seem, therefore, that these substances should retard all physiological processes which depend on the transport of ions through living tissues.

Plants which Require Sodium: W. J. V. Osterhout, Harvard University.

It is generally believed that plants do not require sodium, although it is indispensable for animals. Our increasing knowledge of the biological rôle of salts makes it clear that such a distinction between plants and animals is of fundamental importance, provided it be true in all cases. But if exceptions to it be found its significance largely disappears. I have therefore undertaken to ascertain whether or not there are plants which require sodium and have begun by examining some marine plants. The results are as follows:

The marine plants studied require sodium; its replacement in sea water by NH_4, Ca, Mg, K, Ba, Sr, Cs, Rb or Li is very injurious.

The best substitutes for Na are the other salts of the sea water, Mg, Ca and K.

The diversity in behavior of various species toward the salts which were used to replace the sodium shows that each of these salts has a specific rôle in life processes.

Studies of the Wild Oat: W. M. Atwood, University of Chicago.

Avena fatua (L.) has become a pest agriculturally in the small grain regions of the north and west. In studying its germinative qualities we have found it to possess high vitality. This differs from the deductions which might be drawn from the results of other workers who have tested the seed after periods of burial in the ground.

Avena fatua germinates poorly after harvest, but the per cent. of germination increases steadily up to the succeeding spring and summer.

The early delay of germination appears to be due neither to the chemical condition of the embryo nor to coat obstructions to water entry. Oxygen seems to be the limiting factor to germination which can be forced by breaking the coats or increasing the oxygen pressure.

Investigations are now under way to determine whether the so-called "after-ripening" of the seed is due to alterations in the oxygen demands of the embryo or to increased permeability of the coat to oxygen.

Toxicity of Smoke: Lee J. Knight and William Crocker, University of Chicago.

Molisch has found tobacco smoke extremely toxic to plants of various kinds ranging from bacteria to the highest angiosperms. He finds this toxicity is not due to volatilized nicotine, for cellulose paper smoke is as toxic, but believes it is due to CO.

In the burning of organic compounds the destructive distillation carbon-bearing gases, CO, C_2H_2, C_2H_4 and CH_4 are not generally completely burned and may be the source of injury in the smoke. Exact experiments on the delicate sweet-pea seedling, Early Cromer, shows that smoke from cigarettes, cigars and cellulose paper cigarettes does not contain sufficient CO, C_2H_2 or CH_4 to determine 1/200 the toxicity of the smoke. This leaves C_2H_4, which we have already shown as extremely toxic to plants, as the substance probably determining the toxicity. The injury from smoke in our cities has been attributed to SO_2 and SO_3, *so far as gases are concerned.* The possible effect of the dry distillation of carbon-bearing gases has been entirely neglected. They are produced in small amounts in the burning of coal. This coupled with their extreme toxicity (especially ethylene) makes them probable factors in the smoke question.

A Delicate Test Seedling: William Crocker, Lee J. Knight and R. Catlin Rose, University of Chicago.

We have already published on the characteristic response that the etiolate of sweet pea seedlings give to ethylene. It has been termed a triple response, since it is marked by reduction in rate of elongation, increased growth in diameter and diageotropism. We have since studied the effect of more than fifty gases and vapors upon the seedling, including the paint solvents, the possible impurities of laboratory air, the main constituents of illuminating gas and the principal distillation products of coal tar. The seedlings are apparently reliable and extremely delicate in testing for ethylene—2,000 to 5,000 times as delicate as gas analysis methods. While a few other gases and vapors, carbon monoxide, acetylene, benzene, toluene, xylene, thiophene, cumene and others give the triple response they must be present in such quantities as to be easily detected by other means or they are excluded through impossibility of their

presence in the gas studied. We believe the response of this seedling furnishes a very delicate means of detecting the presence of "heavy hydrocarbons" in laboratory and greenhouse air, in smoke of all sorts and in furnace gases.

The Heat of Absorption of Water in Wood: FREDERICK DUNLAP, U. S. Department of Agriculture.

The heat evolved when water wets dry wood has been studied with the Bunsen ice calorimeter. Oven-dry wood was used; this was sealed in glass to prevent premature wetting. The wood and water were both cooled to 0° C. and brought together at this temperature and the heat evolved was measured. This is large enough to raise the dry wood entering into the reaction from 0° to about 50° C. Under the assumption that the specific heat of wet wood is the sum of the specific heats of the wood and water present in wet wood, its temperature would be raised to about 30° C.

The substance of wood as distinct from the cavities of the cell lumina is saturated when it has imbibed about 25 per cent. of its weight of water. The first per cent. imbibed produces a relatively great evolution of heat; the twenty-fifth, a relatively small evolution of heat, the curve connecting the two being convex upward.

Wood is hygroscopic and its moisture content varies with that of the atmosphere about it. The "working" of wood is due to changes of volume of its substance with changing moisture content. Measures to prevent this "working" aim either to remove the wood from the action of the atmosphere or to render it insensitive to changes in the atmosphere by destroying its hygroscopicity, at least in part. Experiments whose aim it is to destroy the hygroscopicity of wood are now in progress in the Forest Products Laboratory, and this method will be used in studying the changes produced.

Artificial Parthenogenesis in Fucus: J. B. OVERTON, University of Wisconsin.

The occurrence of natural parthenogenesis has been reported for several species among the Phæophyceæ. It is evident that this group shows a strong tendency to develop without fertilization and that natural parthenogenesis may play an important part in the life history of several species. Although Thuret mentions that unfertilized eggs of *Fucus* kept for several days become pear-shaped and that a cellulose wall is sometimes present, none of the Fucaceæ have been described as being able to develop without fertilization.

While working at the Marine Biological Laboratory the past summer, the well-known experimental methods of certain animal physiologists, whereby unfertilized eggs of certain animals have been made to develop under the influence of artificial physical and chemical stimuli, were applied to *Fucus* eggs. In plants used for experiment care was taken to prevent contamination by sperms. That female plants may be made perfectly sterile by washing in fresh water is shown by the fact that none of the eggs of such sterilized plants ever developed in the numerous controls which were run in connection with the experiments. In experimenting, the eggs used at any one time were divided into three lots. One lot was used as a control, another was fertilized and the third was placed for one third minute in a mixture of 50 c.c. of sea-water + 3 c.c. 0.1 *m* acetic or butyric acid. A large number of the eggs treated with these solutions become invested with a cell-wall in about 10 minutes. This wall is exactly similar to the one formed about normally fertilized eggs. The wall is readily seen by plasmolyzing the eggs. After the formation of the membranes, if the eggs are transferred to hypertonic sea-water for 30 minutes and then are brought back into normal sea-water, development continues. Such eggs become pear-shaped, showing a rhizoidal papilla, and by next day have cleaved. If the cultures are kept properly aerated, sporelings of about 25 cells develop in the laboratory, resembling in every respect those grown from fertilized eggs.

It would appear that the action of the acid in inducing cell-wall formation about unfertilized *Fucus* eggs is similar to the action which calls forth membrane formation in the animal egg. Considerable evidence exists indicating that the essential condition for the formation of the fertilization membrane in such eggs is an increased permeability of the plasma membrane to substances which harden in contact with sea-water. That the first effect of the sperm upon *Fucus* eggs is to cause cell-wall formation is apparent from the observations of several investigators.

No attempt was made to grow the sporelings under natural conditions. The methods used by Hoyt and Lewis are suggestive and it seems probable that the sporelings produced parthenogenetically could be grown to sexual maturity, so that the nuclear behavior during oogenesis and spermatogenesis might be investigated.

The Periodicity of Algæ: E. N. Transeau, Illinois State Normal School.

The preliminary observations on algal periodicity given in this paper are based upon a study of eighteen hundred collections made at many stations in eastern Illinois during the past five years. The general richness of the waters of this region may be judged by the fact that the genus *Œdogonium* is represented by more than forty-five species and *Spirogyra* by thirty-five. Field observations indicate that sexual reproduction in nature is induced by a more definite combination of environmental factors than asexual, since the former is usually restricted to a short period of time, while the latter may occur at intervals or continuously throughout the vegetative period of the algæ.

On the basis of the time of greatest frequency, duration of the vegetative cycle and time of reproduction, algæ may be classified as follows:

1. *Spring Annuals.*—Forms whose vegetative period begins in late autumn, reaches its maximum in April and May and is followed by a decline in June. Fruiting occurs in April, May and June.

2. *Summer Annuals.*—Vegetative period begins in spring, culminates in July and August, followed by decline in autumn. Fruiting occurs in July, August and September.

3. *Autumn Annuals.*—Vegetative period begins in spring and early summer, culminates in autumn, decline comes with the beginning of freezing temperatures. Fruiting occurs in October and November.

4. *Winter Annuals.*—Vegetative period begins in autumn, continues through the winter under the ice and culminates in early spring. Fruiting occurs from November to April.

5. *Ephemerals.*—Forms having a vegetative period of a few weeks or days. Fruiting occurs at intervals during all but the winter months.

6. *Perennials.*—Vegetative period continuous with irregularly distributed maxima. Reproduction takes place during the spring, summer and autumn.

7. *Irregulars.*—Forms in which the combinations of conditions necessary for good vegetative development and reproduction occur at irregular intervals, usually of more than a year's duration.

Algæ fruit most abundantly during periods of high water following favorable conditions for vegetative development, rather than during periods of "concentration of the water," "drying up of the ponds," or the coming of "hard conditions." The drying up of pools may coincide with the fruiting of many vernal species, but it results in decreasing the number of spores formed and the number of species that fruit.

The time of fruiting of many algæ is dependent upon combinations of environmental factors rather than on "hereditary rhythm."

A more complete account of these observations will be found in the *Transactions of the American Microscopical Society*, Vol. 32, No. 1, 1913.

On the Presence of Diastase in certain Red Algæ: E. T. Bartholomew, University of Wisconsin.

In the *Florideæ*, starch granules are deposited outside the chromatophores. The granules do not usually give the characteristic reaction when subjected to iodine or zinc chloriodide, but instead turn brown to wine-red. To determine whether or not a diastase is present which will act in the ordinary way on the starch of green plants, extractions were made from the following: *Polysiphonia variegata*, *Ceramium* sp., *Dasya elegans* and *Agardhiella tenera*. A cornstarch paste was treated with various concentrations of these extracts, and after given periods of time tested with Fehling's solution and with iodine. The results showed that although starch digestion was much slower in the tubes treated with the algal extract than in those treated with common commercial diastase, yet the digestion went on and in time was complete; usually taking from six to nine days. In the tubes treated with the algal extract the iodine color-reactions showed that probably a series of dextrins was formed before the starch was completely digested. No doubt the great viscosity of the algal extract materially retarded its action on the paste. By running a series of controls, careful check was kept on each set of experiments. It appears, therefore, that there is present in the *Florideæ* a diastase similar to that found in green plants.

Cytological Studies on Sphæroplea: E. M. Gilbert, University of Wisconsin.

Investigation has shown that many statements made by Klebahn and Golenkin with regard to *Sphæroplea* are inaccurate.

No conspicuous pit-like depressions have been found in partition walls as described by Golenkin.

Cleavage, in the formation of eggs, begins with constrictions from the plasma membrane, and cuts the cell contents into masses of varying sizes. All stages, from those having a single row of large eggs to those having a double row of small eggs may be found in one filament, indicating the possi-

bility that Klebahn saw stages in a single form and not two distinct varieties. I have been unable to find a fusion of many nuclei in the egg as described by Golenkin, nor a multinucleated egg as described by Klebahn.

All nuclear divisions are mitotic, not simply the earlier divisions as noted by Golenkin. There is no fragmentation of the nucleolus to form the chromosomes.

Fertilization does not take place until the egg is fully formed and rounded up; at this time the egg nucleus lies in the center of the egg.

The pyrenoids vary greatly as to size and shape, and the starch is often found to be very irregularly arranged around the central structure.

A Comparison of Plant and Animal Spermatogenesis: CHARLES E. ALLEN, University of Wisconsin.

The development of the androcyte of *Polytrichum juniperinum* into the antherozoid is in several respects closely parallel to the corresponding metamorphosis of the spermatid in certain animals, notably in mammals. For present purposes comparison will be made with the spermatogenesis of the guinea-pig, well known through the researches of Meves.

1. In both spermatid and androcyte the nucleus is at first central, then comes to lie at the extreme side or end of the cell. It undergoes a great diminution in volume, its contents becoming denser and finally homogeneous. The nucleus of the spermatid is finally flattened and curved into the form of the bowl of a spoon; that of the androcyte is drawn out into a long spiral filament.

2. The spermatid possesses two *central bodies;* the androcyte contains the blepharoplast, whose centrosomic nature is a disputed question. From one of the central bodies a contractile filament grows out which becomes the axial filament of the vibratory *tail.* From the blepharoplast grow out two cilia. Out of the central bodies is developed the *end knob* or *middle piece* of the spermatozoon; the blepharoplast forms the anterior end of the antherozoid; in each case the part of the male cell in question is that to which the motile apparatus is attached.

3. The *sphere* or *idiosome* of the spermatid divides into two portions; one, the *acrosome*, forms the anterior end of the spermatozoon; the other, a spherical mass, passes to the posterior part of the cell and is finally discarded with other unused portions of the cytoplasm. The young androcyte contains a spherical body which, like the idiozome, divides into two; one lies close to the anterior end of the blepharoplast, and perhaps persists in the mature antherozoid as a delicate sheath about the blepharoplast; the other, which has been called by Ikeno (incorrectly) the *chromatoid Nebenkörper* and by M. Wilson the *limosphere,* places itself in contact with the posterior end of the elongating nucleus and is discarded with the remaining cytoplasm after the antherozoid becomes free.

4. The androcyte contains a small spherical body which seems to persist but a short time and has no discoverable function; it may be compared with the *chromatoid Nebenkörper* or with the *Nebenkern* of the spermatid, both of which are conspicuous, but temporary and apparently functionless.

5. That part of the cytoplasm in both spermatid and androcyte which is not used in forming the mature cell rounds up into a vesicle; this cytoplasmic residue is discarded by the spermatozoon before maturity, and by the antherozoid after its escape from the antherid.

How far the similarities noted are due to a series of homologies, and how far to the fact that a similar problem is to be worked out by two cells similar but of widely divergent origin, must be left for the present an open question.

Intermingling of Perennial Sporophytic and Gametophytic Generations in Rusts: E. W. OLIVE, Brooklyn Botanic Garden.

The Individuality of Chromosomes in the Somatic Cells of Gentiana procera: R. H. DENNISTON, University of Wisconsin.

The nuclei in the cells of the nucellus and integument were the ones especially studied.

The material is favorable, because the chromatin appears in the resting stages in deeply stained, well-defined masses.

In this plant there is a large number of chromosomes, about eighty. These appear closely massed together in the equatorial plate stage.

In the metaphase the chromosomes are pulled away from each other toward their respective poles. In this view the chromosomes appear as short curved rods.

The chromosomes do not lose their identity in the diaster stage, as here and there an individual can be plainly seen projecting from the mass.

The long axes of the individual chromosomes conform in general direction with the long axis of the spindle.

After the closely packed condition of the chromosomes in the diaster, they move apart somewhat,

each group appearing to occupy more space. At this time no apparent change in the density or size of individuals has taken place, but their axes now lie in many directions. The nuclear membrane appears and the nucleus has the form of an oval with the shorter diameter in the direction of the spindle. It may be that the spreading apart of the chromosomes is for the purpose of facilitating their growth, as they now appear somewhat larger. Probably the chromosomes do not grow, but become less dense, since they do not stain so intensely at this time. The nucleoles make their appearance as small oval bodies, from one to four in number. These usually combine later, to form a single nucleole.

The chromosomes now appear to become angular and to lose their curved form. Threads of linin appear and portions of the chromatin appear to be drawn out along these threads. No continuous spirem is formed, however. The chromosomes now come together in groups, forming various-sized homogeneous, angular masses. This is the condition in which the chromatin is found in the greater number of so-called resting cells in the Gentian. There are also present small particles of chromatin material along the linin threads which connect the larger masses. There is no uniformity in the number of the larger masses, and in this plant there is no indication of prochromosomes, *i. e.*, there is no relation between the number of chromosomes and the number of these masses.

Each mass appears to be composed of smaller fairly distinct bodies, but these smaller bodies do not represent the chromosomes, since they are much more numerous and vary in size. These small bodies later become arranged along the linin thread, forming a spirem.

The spirem increases rapidly in diameter, takes a homogeneous stain, and occupies a peripheral position in the nucleus. Irregularities on the surface of the spirem suggest the position of the chromatin bodies of which it was made up. Segmentation of the spirem follows and the chromosomes are formed.

These are long at first, but soon shorten to rod-like bodies, three or four times as long as broad. They are distributed throughout the nucleus and pairing does not appear to take place.

The main points in the history of the chromatin in the somatic cells of this plant are:

1. The aggregation of chromosomes in the diaster, from which, later, the chromosomes separate out.
2. The absence of a dispirem.
3. The presence in the resting nucleus of chromatin masses which vary in size and shape.
4. The breaking up of these chromatin masses into smaller fragments, more numerous than the chromosomes.

Physiological and Economic Significance of the Structure of the Tracheids of Conifers: I. W. BAILEY, Harvard University.

The so-called striated tracheids of conifers are a specialized type of tissue structurally organized to resist compression. Gothan's hypothesis that "spiralstreifung" are spiral cracks confined to heartwood, and are produced by chemical changes and mechanical stresses in the transformation of alburnum into duramen, is not substantiated by a study of the origin and distribution of striations in the various coniferous genera.

Cracking or slitting of tracheid walls in drying occurs sporadically and is confined to the so-called summerwood. Tiemann in his "slit" theory of the penetration of gases and preservatives into seasoned wood has not taken into consideration the important fact that drying-cracks do not rupture the middle lamella and are confined to the secondary and tertiary walls. Injection experiments show that the membranes of bordered pits in freshly cut green sapwood are perforated and permeable to gases, colloids and finely divided solids held in suspension.

The Leaf Trace and Pitting of the Araucarineæ and their Relation with those of the Cordaitalean Forms: R. B. THOMPSON, University of Toronto.

The venation of the Araucarian and Cordaitalean leaves is typically dichotomous, though in some of the modern forms a false trichotomy has been acquired. In both groups the dichotomous condition persists in the secondary wood, *double traces* extending to the pith in many instances. The bundles of the double trace are far apart in the seedling of *Agathis*. Ginkgo has been up to the present the classical example of the double trace in the secondary wood for comparison with the Cordaitalean forms. The double trace in the *cortex* of the Abietineæ has been considered a vestige of this condition.

In pitting, the cone and root of the Araucarineæ show a more accentuated Cordaitalean character than that of the stem. The ordinary tracheids of the cone, for example, may have the pits as much as 5-seriate and extending from end to end of the tracheid. The ray-pitting of the tracheids retains

the multi-seriate condition longer than the adjacent part, where tracheid is in contact with tracheid. This is a contrast to some of the Abietineæ where the ray pitting consists of "Grosseiporen" derived from the fusion of smaller pits.

Both leaf traces and pitting are considered as indicating the Cordaitalean connection of the Araucarineæ and as directly opposed to the derivation of the Araucarineæ from the Abietineæ. The anatomical evidence is thus in accord with the geological, since, as has been recently shown, the forms of the older strata which were thought to have been Abietinean have proved not to be authentic.

Macrozamia Moorei, a Connecting Link between Living and Fossil Cycads: C. J. CHAMBERLAIN, University of Chicago.

A Possible Means of Identifying the Sex of + and — Strains in the Mucors: A. F. BLAKESLEE, Carnegie Institution.

Certain of the hermaphroditic species of the mucors are distinctly heterogamic, forming regularly large female gametes and smaller male gametes. By growing the (+) and (—) races of an isogamous diœcious species in contrast with such an heterogamic hermaphroditic species, a sexual reaction has been found to occur between female branches of the hermaphrodite and branches of the (—) race, on the one hand, and between male branches of the hermaphrodite and branches of the (+) race on the other hand. This reaction would lead one to consider the (—) race male and the (+) race female.

A Suggestion as to the Phylogeny of the Ascomycetes: ERNST A. BESSEY, Michigan Agricultural College.

Of the two suggested points of origin of the Ascomycetes, the Phycomycetes are excluded in view of their non-septate plant body and the simplicity of the structures resulting from the sexual union. Many of the red seaweeds, on the other hand, have a plant body in many respects similar to that of the Ascomycetes, *i. e.*, septate with a single rather large pit or pore in the septum, the segments being in both groups either uni- or plurinucleate. In both groups, the result of the sexual union is a "spore fruit," *i. e.*, a more or less extensive mass of branches from the female cell terminating in the reproductive cells. The fact that a number of red seaweeds are known which lack chlorophyll and are strictly parasitic upon other algæ (red seaweeds), very often surrounding and separating the cells of the host in a manner similar to that shown by the lichens with reference to their hosts and the fact that in the reproduction of the latter group, *e. g.*, *Collema*, the male elements are, as in the red seaweeds, nonmotile sperm cells, suggests that lichens may represent a group derived from some of the more primitive red seaweeds, probably inhabitants of fresh water, that became parasitic upon colonies of Nostoc or other algæ and gradually assumed the terrestrial habit. The apothecium would correspond to the cystocarp and the ascus would phylogenetically have some relation to the carpospore. From such lichens have been derived then the non-lichen Discomycetes, on the one hand, and perhaps through the closing and becoming more firm of the apothecium, may have arisen the Pyrenomycetes. Similarly the teliospores of the rusts and smuts would be homologous to the carpospore.

Morphogenesis in Pediastrum: R. A. HARPER, Columbia University.

In the genus *Pediastrum* we find all degrees of variation in cell differentiation from species in which the colonies are composed of cells which are practically all alike to others in which only the peripheral cells are provided with well-developed spines, while in the central region the spinous projections are only slightly indicated by the kidney-shaped form of the cells with the reentering angle on the outer side. In the species with uniform cells these may show either very long spinous processes or almost none at all. The reproduction of the colonies by motile zoospores, which after swarming for from five to fifteen minutes arrange themselves spontaneously in the plate-shaped new colony shows that as in *Hydrodictyan* the form of the colony is not predetermined by any spatially differentiated representation of the adult in the organization of the germ plasm. The cells arrange themselves in accordance with the principle of least surfaces modified by their specifically inherited cell form and the law of reproduction by bipartition. All the cells of a given species are in general alike in their inherited form and capacities for differentiated growth, and are totipotent. The differentiation between cells in species which show it is due to cellular interaction in the formation and growth of the colony. This morphogenetic equivalence of the cells is most clearly shown in cases in which the cells are abnormally or unusually situated as a result of unfavorable environmental conditions. All the species share an inherited tendency to produce one or two spines

on one side of the cell. The degree to which these spines are developed in a given colony is determined by cellular interactions. The degree to which the tendency is present in different species is the basis for the delimitation of species in the genus. All the cells show also a polar differentiation, the spines being produced in the direction of the shorter of the two major axes of the cell. There is some evidence also of specifically oriented attractions between the cells such that the spines in normal individuals come to point radially outward in the interior as well as in the peripheral cells of the colony. Specifically inherited cell form and cellular interactions during growth are the principal morphogenetic factors in the development of the differentiated cell colonies of *Pediastrum*.

Tetradesmus, a New Four-celled Cœnobic Alga: G. M. SMITH, University of Wisconsin.

Tetradesmus resembles *Scenedesmus* in the number and shape of the cells, but differs from it in the cellular arrangement, the cells being in two planes, each plane containing two cells.

The reproduction is by autocolonies. The first cleavage of the mother cell is transverse and the second is in the same plane and diagonal to the line of the first cleavage. After the four daughter cells have been formed by cleavage they elongate, while still within the mother cell, taking the same relative position that they have in the mature colony. The young colony is liberated by a longitudinal rupture of the mother cell wall.

The mature cell possesses a nucleus and a pyrenoid. The nucleus divides once before the first cleavage takes place, but the pyrenoid does not. When the four daughter cells have been formed, the old pyrenoid of the mother cell is found in one of them while the other three contain no pyrenoid. This pyrenoid then disappears and pyrenoids are formed *de novo* at the time that the daughter cells are elongating prior to their liberation from the old mother cell wall.

The Relation of the Lichen to its Algal Host: BRUCE FINK, Miami University.

The common algal hosts of lichens; finding the algal hosts growing near lichens in nature; cultures of lichens from spores and spermatia with and without the algal hosts; cultures of the algal hosts separately; growth of lichen hosts and other algæ on media with and without light and carbon dioxide; breathing pores and other means of aeration of the algal hosts in lichens; lichens as carriers of food to the algal hosts; hypotheses regarding the relationship of the lichen and its algal host, with evidence from recent research.

A Dry Rot of the Irish Potato Tuber: E. M. WILCOX, University of Nebraska.

In 1908 our attention was called to the fact that potatoes grown in western Nebraska were often seriously injured by a form of rot during storage. Comprehensive investigations were undertaken to learn the exact cause and nature of this disease. It was found to be due to a new species of *Fusarium*, shortly to be published as *Fusarium tuberivorum* Wilcox and Link. Numerous inoculation experiments have established the causal relation of this organism to this tuber dry rot. The organism is, however, unable to invade any other part of the plant than the tuber, and the tuber only when it is practically mature.

The Propagation of Medicinal Plants: F. A. MILLER.

An Optimum Culture Medium for a Soil Fungus: J. B. POLLOCK, University of Michigan.

The work was done in collaboration with Miss Rose M. Taylor, and had for its object the determination of an optimum culture medium of exactly known composition and of simple constitution. The fungus chosen was one isolated from the soil by H. N. Goddard, and determined as a new species of Myceliophthora, to be described by him elsewhere under the name of *Myceliophthora sulphurea*. The medium aimed at was one with the fewest and simplest compounds which would furnish the chemical elements necessary for the growth of fungi. It is known that fungi will grow with as few as eight of the known elements, namely, carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, potassium and magnesium. In the experiments sixteen organic compounds were tested as to their availability for carbon, and incidentally they could also supply hydrogen and oxygen. These carbon compounds were saccharose, dextrose, maltose, inulin, lævulose, arabinose, mannite, cellulose, resin, starch, glycocoll, alanin, asparagin, glycerine, potassium tartrate and sodium benzoate. The compounds tested as to their availability for nitrogen were ammonium sulphate, ammonium nitrate, sodium nitrate, potassium nitrate and calcium nitrate. In all the cultures magnesium sulphate was used to supply magnesium and sulphur. This was used in only one concentration, 1/1000 that of a gram-molecular solution = 1/1000 M. Mono-potassium phosphate was used to furnish phosphorus and potassium, and it was used in several concentrations, 1/10,

1/25, 1/50 and 1/100 M. Nitrogen compounds were used in concentrations of 1/5, 1/25, 1/125, 1/250 and 1/500 M. Preliminary experiments soon showed that this fungus could not obtain carbon from several of the compounds tried and that others had only slight availability. Only maltose, saccharose and dextrose were tried out for final results, in concentrations of 1, 2/5, 1/5, 1/10, 1/25, 1/125, 1/250, 1/500, 1/625 M.

Twenty-four sets of cultures were carried through, the number of flasks in a set ranging from six to forty-eight. The test applied for the optimum medium was the amount of vegetative growth, estimated by the eye alone in the early stages of growth for all the cultures, but in cases where the results were doubtful and also for the purpose of getting quantitative results for some of the work, in several sets the growth was determined by weight.

Conclusions.—Of the nitrogen compounds tried calcium nitrate was the best. Its best concentration was 1/250 M. 1/125 and 1/500 M were nearly as good. Sodium nitrate was next best, ammonium sulphate was very decidedly the poorest. In the early stages of growth ammonium nitrate was little better than ammonium sulphate, but given a longer time it became equal to potassium nitrate, and the latter was only slightly below sodium nitrate.

The different concentrations of the phosphate had little influence on the amount of growth, 1/10, 1/50 and 1/100 M being almost equally good, except that with cellulose as the carbon compound little growth was made with the concentration of the phosphate 1/50 or 1/100 M, while there was very good growth in 1/10 M.

Among the carbon compounds maltose was decidedly the best when ammonium nitrate was the source of nitrogen, but with calcium nitrate saccharose was as good or better. For all the three carbon compounds saccharose, dextrose and maltose, the concentration of 1 M was strongly inhibitive of growth. In 1/5 M the growth was far better than in any of less concentration. The experiments in which 2/5 M was used gave a slightly greater total than 1/5 M, but the rate of growth in the former was decidedly slower than in the latter. It was true in a good many sets of cultures that the rate of growth was more rapid in the more dilute solutions, though maximum growth occurred in more concentrated solutions.

Of the substances and concentrations tried the optimum medium for the fungus tested was:

Saccharose	2/5 M.
Calcium nitrate	1/250 M.
Monopotassium phosphate	1/10–1/100 M.
Magnesium sulphate	1/1000 M.

Saccharose has one very decided advantage over both dextrose and maltose. It may be obtained in a purer form. The ordinary rock candy obtainable at any candy store is far more nearly chemically pure than the grades of maltose and dextrose obtained from reliable dealers and labeled C.P. This is a very decided advantage in critical culture experiments.

A Labeling Surface for Laboratory Glassware: A. F. BLAKESLEE, Carnegie Institution.

Diamond ink applied to glassware gives a permanent ground-glass surface upon which labels can be written with lead pencil. Labels upon this surface are of especial value upon flasks, test tubes, etc., that need to be sterilized in autoclav.

GEORGE T. MOORE,
Secretary

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE 465th regular meeting of the Anthropological Society of Washington, D. C., was held at Room 43 of the new building of the National Museum at 4:30 P.M., January 21, 1913, Mr. George R. Stetson, the president, in the chair.

Dr. Tom. A. Williams, M.B., C. H. Edin., M. Corresp. Etrang. Soc. de Neurologie de Paris, Soc. de Psychol. de Paris, etc., charter M. Am. Psychopath. Assoc., Collaborator *Jour. Abnorm. Psychol.*, read a paper on "The Dream in the Life of the Mind."

Trance, vision, ecstasy and disease-delirium are closely allied to the dream state. The psychopathology of them all illuminates formerly uncomprehended diseases. In a dream (illustrated by a case) mental perturbation may crystallize, as it were, and lead to rampageous behavior. On the contrary, dreams may be teleologically beneficial; as where a vision saved a young woman from suicide, as was the case also with Benvenuto Cellini.

They are more often a mere reproduction of former experiences, more or less significant and more so in psychopathic individuals, such as in a young hysteric who dreamed of falling down wells, assassinations and deaths, all painful experiences of her childhood.

Their sexual nature, believed inevitable by a certain school, is not so regarded by the author.

Nor is their analysis an essential of proper diagnosis and treatment of psychopathies. But in some cases they render the investigation more easy.

Dream-thought, apparently confused, is really significant of the mental trend of the individual, when properly analyzed and interpreted. One dreams all the time, but recollects only that within seven minutes of waking. The form of dream can be determined by external stimuli. This is demonstrated in spite of its contradiction by some psychopathologists.

A SPECIAL meeting of the Anthropological Society of Washington was held on February 4, 1913, at 4:30 P.M. in Room 43 of the new building of the National Museum, the president, Mr. George R. Stetson, in the chair.

Dr. Clark Wissler, curator of the department of anthropology in the American Museum of Natural History, New York, read a very elaborate and philosophical paper on the "Doctrine of Evolution and Anthropology."

An attempt was made to distinguish between cultural phenomena on one hand and biological on the other, especially to make clear that cultural phenomena are not inherited, though the instinct to develop culture, or to invent, is most certainly inborn. It was suggested that the historical attitude of present-day anthropology should be taken as expressing the cultural point of view. Culture itself seems to be associated habit complexes or constructs of the mind and not to be in any way innate or inborn, but to be an external affair, preserved and carried on entirely by learning or educating processes. Cultures develop and have an evolution of their own, but since they are not inherited they can not be considered parts of a biological development. They are most assuredly facts of another order. Being products of the mind, the only limitations put upon them are to be sought in the mind itself and since psychologists tell us that we have in the main only an associated cultural whole, resolvable into psychological elements and since this, in turn, is only a matter of invention and not of cell differentiation. Being a matter of invention, the genetic relationship becomes purely a matter of history, since we can not foretell what the relationship is.

The psycho-physical mechanism of man is biological and innate and constitutes man's equipment for the production of cultures. Anthropology holds that the mechanism is general in so far as it is not limited to any particular culture, and that it enables the individual to practise any culture he may meet, though not necessarily to equal degrees.

When we come to consider the biological theory of evolution we find that it applies to the psychophysical mechanism but not to culture. For cultures we must have another point of view or theory and this in America, at least, is the historical or cultural conception. This conception is in general that cultural traits are the results of invention, a mental process, and their development or evolution is to be taken as a historical and psychological problem.

The paper was briefly discussed by Dr. Folkmar, Dr. Swanton and Dr. Hough.

WM. H. BABCOCK,
Secretary

PHILOSOPHICAL SOCIETY, UNIVERSITY OF VIRGINIA
MATHEMATICAL AND SCIENTIFIC SECTION

THE third meeting of the session 1912–13 of the Mathematical and Scientific Section was held on December 16.

Professor A. H. Tuttle made a preliminary report of work now in progress upon the life-history of the Charales, based chiefly upon cytological studies of a species of *Tolypella*.

The fourth meeting of the session 1912–13 of the Mathematical and Scientific Section was held on January 20.

Professor J. T. Singewald, of the Johns Hopkins University, read a paper on "The Titaniferous Ores of the United States."

WM. A. KEPNER,
Secretary

UNIVERSITY OF VIRGINIA

THE ELISHA MITCHELL SCIENTIFIC SOCIETY

THE 203d meeting of the society was held in Chemistry Hall, University of North Carolina, on Tuesday evening, February 11. The following program was presented:

"Photography of Sound Waves," by Mr. A. H. Patterson.

"Difference in the Effect of Grehant's Anesthetic and of Morphine Ether on the Output of Urine by Nephritic Animals," by Dr. W. B. MacNider.

"The Chemical Action of Light," by Dr. A. S. Wheeler.

JAMES M. BELL,
Recording Secretary

CHAPEL HILL, N. C.

SCIENCE

FRIDAY, MARCH 14, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE REGULATION OF NEUTRALITY IN THE ANIMAL BODY[1]

IT was a favorite figure of Cuvier's, recurring again and again in his works,[2] to compare life with a vortex into which molecules continually enter, from which they continually depart; meantime the vortex remains, and thus the form of a living thing appears to be more important than the substance. Cuvier's analogy, though almost forgotten, is quite as valid to-day as a century ago, but I suspect that the modern physiologist will be disposed to see in such a view a justification of the study of *conditions* rather than a claim for morphology. What, indeed, is the importance of the anatomy of a whirlpool in comparison with the dynamics thereof?

Now it is the study of conditions within the organism which physical chemistry has contributed to physiology—solution, surface tension, the colloidal state, osmotic pressure, ionization, alkalinity or neutrality—and these are dynamical equilibria rather than in any sense morphological elements. To such conditions Cuvier's figure exactly applies, and provides, moreover, the very best means for their systematic investigation; while the conditions, in turn, most fully reveal that which was partly made clear to Cuvier by the imagination of genius, and, in spite of it, quite certainly in part unknown to him.

The right working of physiological proc-

[1] Read in the joint meeting of Section K of the American Association, the American Physiological Society and the American Society of Biological Chemists at Cleveland.

[2] See Merz, "A History of European Thought in the Nineteenth Century," Vol. I., p. 129.

esses depends, then, upon accurate adjustment and preservation of physico-chemical conditions within the organism. Such conditions as temperature, molecular concentration and neutrality are now known to be nicely adjusted and maintained; adjusted by processes going on in the body, maintained by exchanges with the environment. This paper is concerned with those physiological processes whereby the normal reaction of the body fluids is permanently preserved.[3]

Throughout the human body, while life exists, there occurs a regular formation of acid substances, excretory products of metabolism. As they form, these various matters, carbonic acid, sulphuric acid and phosphoric acid in the main, immediately combine, but only partially, according to their several avidities, with the basic constituents of protoplasm and blood. In pathological conditions great quantities of acetoacetic acid and β-oxybutyric acid may be produced and claim their share of base. At irregular intervals varying quantities of acids and bases pour in with the food. Thus, through resulting changes in equilibria between bases and acids, normal metabolism steadily operates to lower the unvarying alkaline reaction (almost neutrality[4]) of the body. This tendency to acidity is held sharply in check by special protective mechanisms, acting coordinately, in cooperation and regular succession.

The chemical reactions whereby such material is first neutralized, the chemical substances which aid in neutralization, the shares of more important substances in the process, and their efficiency, the changes in chemical equilibria, including resulting changes in hydrogen and hydroxyl ion concentrations, all, *so far as they concern true solution*, are known with a fair approach to certainty. Principally this work of neutralization is done by salts of phosphoric and carbonic acids, with aid from the amphoteric proteins. In simplified form the process may be represented by the two reactions,

$$M_2HPO_4 + HA = MA + MH_2PO_4;$$
$$MHCO_3 + HA \rightleftharpoons MA + H_2CO_3,$$

where M stands for any basic radical, A for any acid radical. Other less important simultaneous reactions are of the same type, except perhaps the union of the weak acids with basic proteins like globine, and the union of bases with more acid proteins. Through the remarkable circumstance that phosphates and carbonates possess, among all known chemical substances, the highest power to preserve neutrality in solution,[5] this function is so well performed that the alkaline reaction of the body scarcely varies, even when the load upon the mechanism is heavy.

But, however efficient such an arrangement may be, it is of its very nature only the first stage in the process of the excretion of acid, and wholly dependent upon constant support by the kidney, and of course upon a supply of alkali in the food. Regularly, as they form, the acid bodies must be afforded alkali by blood and protoplasm, for every molecule of carbonic acid about 0.93 molecule of alkali, for every molecule of phosphoric acid 1.89 molecules of alkali, and for every molecule of sulphuric acid 2 molecules of alkali, in accordance with chemical laws and the normal reaction of the body. Clearly, therefore,

[3] See L. J. Henderson, "The Theory of Neutrality Regulation in the Animal Organism," *American Journal of Physiology*, XXI., 427, 1908, and "A Critical Study of the Process of Acid Excretion," *Journal of Biological Chemistry*, IX., 403, 1911.

[4] The terms may be used interchangeably for an alkalinity which is so slight.

[5] L. J. Henderson, *American Journal of Physiology*, XXI., 173, 1908.

this neutralization must rest upon physiological processes which serve to reestablish the original conditions, for if such great amounts of alkali were discharged from the body with the acid excretory substances, the organism would lose its protection and acidity would speedily ensue throughout the system. Thus an imperative necessity arises for the retention of a part of the alkali which serves as a carrier in the process of removing acid from the body. Of course the necessary magnitude of such alkali retention by the kidney varies with the net amount of alkali ingested and with the acid formation of the body.

The conditions in man are closely paralleled by those in other higher animals, and there is reason to believe that constancy of alkalinity is quite the earliest and most universal physico-chemical regulation of active protoplasm. In fact, as the investigations of Palitzsch[6] show, the ocean itself is likewise quite constant in its alkalinity. It is worthy of note that this is due to the simultaneous presence of carbonic acid and bicarbonates in the sea water, a fact which lends support to Macallum's ideas about the derivation of the body fluids. Thus active protoplasm everywhere, as well as that which surrounds it —the environment and the *milieu intérieur* —appear to be and to have been always of stable reaction.

According to the modern theory of solution water itself, like the dissolved electrolytes, is dissociated into ions, though only to a very slight degree. The reaction is expressed thus:

$$H_2O = \overset{+}{H} + O\overset{-}{H}.$$

If the water be pure the concentrations of hydrogen and hydroxyl ions are necessarily equal, for water is electrically neutral. A variety of independent methods of estimation have shown that at 25° this concentration amounts almost precisely to N/10,000,000 in the ordinary units. This corresponds to 0.0000001 gram of ionized hydrogen and 0.0000017 gram of ionized hydroxyl in 1,000 grams of water. Further, the theory of solution explains acidity in water by the occurrence of hydrogen ions, formed from dissolved electrolytes, in excess of hydroxyl ions; and alkalinity by a similar excess of hydroxyl over hydrogen ions. Neutrality is, accordingly, the condition when, as in pure water, the two concentrations are equal. In short, expressing the concentration of ionized hydrogen by $(\overset{+}{H})$ and of ionized hydroxyl by $(O\overset{-}{H})$, if

$$(\overset{+}{H}) = \frac{N}{10,000,000} = (O\overset{-}{H})$$

the solution is neutral. If

$$(\overset{+}{H}) > \frac{N}{10,000,000} > (O\overset{-}{H})$$

the solution is acid. If

$$(\overset{+}{H}) < \frac{N}{10,000,000} < (O\overset{-}{H})$$

the solution is alkaline.

It remains to point out that implicit in these definitions is the well-founded hypothesis that in water the concentrations of hydrogen and hydroxyl ions vary inversely, so that, with constant temperature, under all circumstances their product is constant:

$$(\overset{+}{H}) \times (O\overset{-}{H}) = K.$$

Thus the nature of acidity and alkalinity may readily be represented by a straight line with the neutral point at its center, acidity increasing in one direction, and alkalinity in the other.

Whenever a weak acid is present in aqueous solution in company with such bases as sodium, potassium, calcium, magnesium, etc., which are invariable constitu-

[6] *Comptes-rendus des travaux du Laboratoire de Carlsberg*, X., 85, 1911.

					Acidity							Alkalinity			
$(\overset{+}{H})$	1	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}	10^{-11}	10^{-12}	10^{-13}	10^{14}
$(\overset{-}{OH})$	10^{-14}	10^{-13}	10^{-12}	10^{-11}	10^{-10}	10^{-9}	10^{-8}	10^{-7}	10^{-6}	10^{-5}	10^{-4}	10^{-3}	10^{-2}	10^{-1}	1

ents of the ocean, blood, protoplasm, etc., *provided the acid be in excess,* it is a simple matter to determine the reaction, which can best be measured by the values of $(\overset{+}{H})$ and $(\overset{-}{OH})$, following the considerations above.

For this we possess a host of reliable data and a tried and well-seasoned theory —the mass law. Now there is, in connection with the application of the mass law to ionization, a certain characteristic property of an acid, its ionization constant, k, which measures its tendency to dissociate in aqueous solution, thereby to produce hydrogen ions, and hence to increase the intensity of acidity. Strong acids have ionization constants which are of the order of magnitude of 1.0, weak acids of the order of magnitude of 0.0001, the weakest acids, 0.00000001, or less.

TABLE OF IONIZATION CONSTANTS

HCl, HNO_3, etc.	1
H_3PO_4	0.011
H_3AsO_4	0.005
HNO_2	0.0005
H_2CO_3	0.0000003
NaH_2PO_4	0.0000002
H_2S	0.000000091
H_3BO_3	0.0000000007
Na_2HPO_4	0.0000000000000036

It has been discovered that in the general case above discussed of weak acid and salt, the concentration of ionized hydrogen is always almost exactly proportional to the ratio of free acid to salt, and is equal, in very close approximation, to the product of this ratio by a number slightly greater than the ionization constant of the acid. That is to say, representing free acid by HA and salt by BA,

$$(\mathrm{H}) = k \times \frac{HA}{BA},$$

whence, if $k = (\overset{+}{H})$

$$\frac{HA}{BA} = 1.$$

From this relationship therefore follows the conclusion, fully established by experiment, that whenever in such a solution the excess of acid, HA, is chemically equivalent to the quantity of salt, BA, the hydrogen ion concentration is almost exactly equal to the ionization constant of the acid, and this is one of the very best methods quickly to detect and characterize an acid. But the ionization constant of carbonic acid (first hydrogen atom) at room temperature is 0.0000003. Hence, in a solution containing exactly equivalent quantities of free carbonic acid, for example, sodium bicarbonate, the hydrogen ion concentration must be approximately 0.0000003 N. Further, since

$$\frac{HA}{BA} = \frac{(\overset{+}{H})}{k},$$

if the amount of acid be ten times the amount of salt

$$\left(\frac{HA}{BA} = 10\right)$$

the hydrogen ion concentration must be about 0.000003 N, and if the reverse be the case

$$\left(\frac{HA}{BA} = \frac{1}{10}\right)$$

the value must be nearly 0.00000003 N.

The range of variation of concentration of hydrogen ions in the usual solutions of the chemical laboratory considerably surpasses the limits of 1.0 N and 0.00000000000001 N. In comparison with such enormous differences those between 0.000003 N and 0.00000003 N are almost negligible (1/100 : 1/100,000,000,000,000). Hence ordinarily it is quite accurate enough to speak of any

solution containing both free carbonic acid and a bicarbonate, when the disparity between the concentrations of the two substances is not very great, as of constant reaction. For, obviously, the neutral point, which at a temperature of 25° amounts to a concentration of hydrogen and hydroxyl ions 0.00000001 N, falls well within the narrow range of reaction of such solutions, being characterized by a ratio of carbonic acid to bicarbonate of about 1:3.

Thus carbonic acid, like the almost equally weak acid, phosphoric acid (after its first hydrogen has been neutralized by base), has the remarkable property of preserving a neutral reaction whenever it exists in solution with its salts, provided there be an excess of acid. All acids whose strength is even a little either greater or less than carbonic acid lack the property. There is nothing mysterious about this fact; any other weak acid will hold constant the reaction in its own range of reaction; thus acetic acid in the neighborhood of a hydrogen ion concentration N/100,000, etc.

This characteristic of carbonic acid is of the utmost significance, first by regulating one of the most fundamental of physico-chemical conditions, and secondly, by preserving throughout nature the characteristic chemical inactivity of water, which disappears whenever the reaction becomes either appreciably acid or appreciably alkaline. Almost the only case of important geological action due to acidity or alkalinity of water is the action of fresh water, containing carbonic acid itself, to weather the rocks. This process is however self-limited, for the dissolved material forms bicarbonates, and thus at once provides permanently balanced solutions.[7]

[7] L. J. Henderson, "The Fitness of the Environment," Chapters IV. and V. New York, The Macmillan Company, 1913.

Elsewhere, within and without the organism, carbonic acid is almost always accompanied by bicarbonates, and a close approach to neutrality is the result. In the organism the variation in ratio of phosphates is similar to the case of the carbonates, as may readily be illustrated by experiment. Thus a solution consisting of equal parts of monosodium phosphate and disodium phosphate will be found to give a neutral reaction with both methyl orange and phenol phthalein, and the neutrality, thus indicated, will not be disturbed by the addition of relatively large amounts of either acid or alkali.

We may next consider the equilibrium within the organism, where the concentration of ionized hydrogen can undoubtedly vary between 5 N/100,000,000 and N/10,000,000, but during life probably not much more widely, in the body at large. At body temperature the most probable values of the ionization constants of the acids in question yield the equations:

$$(\overset{+}{\mathrm{H}}) = 6.9 \times 10^{-7} \times \frac{H_2CO_3}{NaHCO_3},$$

$$(\overset{+}{\mathrm{H}}) = 2.1 \times 10^{-7} \times \frac{NaH_2PO_4}{Na_2HPO_4}.$$

If

$$(\overset{+}{\mathrm{H}}) = 0.5 \times 10^{-7}\ \mathrm{N}$$

$$\frac{H_2CO_3}{NaHCO_3} = \frac{1}{13.8}, \quad \frac{NaH_2PO_4}{Na_2HPO_4} = \frac{1}{4.2},$$

and if

$$(\overset{+}{\mathrm{H}}) = 1.0 \times 10^{-7}\ \mathrm{N}$$

$$\frac{H_2CO_3}{NaHCO_3} = \frac{1}{6.9}, \quad \frac{NaH_2PO_4}{Na_2HPO_4} = \frac{1}{2.1}.$$

In short, in order to bring about this seemingly insignificant change in reaction, the relative quantities of acid and base in the body must undergo very great changes; or, otherwise stated, until very large quantitative changes in the amount of acid or base in the body have come about, there can be no appreciable change in the reaction.

In the case of carbonic acid the equilibrium is further complicated by the activity of the lung in excreting the free acid and regulating the concentration of that substance, which is kept nearly constant. Thus, when acid reacts with bicarbonate in the body, it diminishes the latter substance without increasing the amount of the acid. In this manner through the escape of carbonic acid, the efficiency of the equilibrium in the preservation of neutrality is further greatly increased. Thus it is that even in extreme acid intoxication, as for instance diabetic coma, almost the only chemical change that can be detected, as a result of the action of enormous quantities of acid through long periods of time, is a large diminution in the bicarbonates of the blood; in the instances above calculated this would amount to a decrease of about 50 per cent. in the total carbonic acid. Meantime about 20 per cent. of the phosphoric acid of the body will probably be changed from alkaline to acid phosphate, and the proteins will have given up a portion of the alkali with which they are combined.

The recognition of the fact that diminution of bicarbonates is the principal effect of acid intoxication upon the blood, involves important consequences. On the one hand it has become clear that the therapeutic use of sodium bicarbonate is desirable in a large variety of pathological conditions and, on the other hand, it seems to be certain that the evil effects of acidosis largely depend upon interference with the transport of carbonic acid and its excretion from the body. In truth this equilibrium is intimately associated with the respiratory function, and with a great number of other fundamental physiological activities, and with the osmotic pressure of the cell.

Further the profound influence of hydrogen and hydroxyl ions upon many enzymatic processes, and upon colloids in general has been established, and it is gradually becoming clear that all the physico-chemical conditions in protoplasm—alkalinity, osmotic pressure, colloidal swelling, chemical equilibrium, temperature—are interdependent, and that carbonic acid and the acid-base equilibrium are among all these things probably the most important variables.

The reason why it may be asserted that carbonic and phosphoric acids and the proteins are the only important substances which are involved in the physiological regulation of neutrality is that, for the body as a whole, in the narrow range of reaction which can actually occur, these substances can neutralize about 30 liters of 0.1 N acid, and nothing else except other substances of like ionization constants, in equal concentration, even with the advantage of the escape of acid, can do as much.

It can not be too strongly emphasized that this conclusion applies only to the true aqueous solutions of the body. Of the colloidal phase we have no knowledge, but it is evident that they may act as reservoirs of supply and as vehicles of escape.

It is also evident that, if enough acid be produced locally, for instance, lactic acid in the muscle, the protective mechanism may be overthrown, and true acidity result. There is an important connection between this consideration and theories of fatigue and muscular contraction.

But, as for the assertions themselves, they rest upon one of the immutable properties of matter. Phosphoric and carbonic acids in solution everywhere possess this characteristic, independent of the presence of everything else, just as they everywhere possess their characteristic chemical composition.

Thus it is that the regulation of reaction of blood and protoplasm manifests the very highest stability.[8]

In exactly the same way that neutrality is favored by the ionization constant of phosphoric acid, the excretion of acid is facilitated. By variation of the relative amounts of acid and alkaline phosphates the relative amounts of acid and basic constituents of the urine may be varied in the highest degree, accompanied by the very smallest possible variations of hydrogen ion concentration. Thus the presence of phosphoric acid makes of the urine an ideal regulatory apparatus for the preservation of the normal ratio of acid to base in the blood.

Such are the more striking aspects of this subject. Neutrality is quite as definite, quite as fundamental and quite as important a characteristic of the organism as its temperature, or osmotic pressure, or in fact anything else that we know. And it turns out to possess those remarkable characteristics of stability that have been revealed by the researches of Rubner and others in the case of temperature, only in far higher degree.

Within wide limits of amount any acid or base may be poured into the organism, and the reaction will not vary; nor will it vary if such be produced by the organism, and this constancy will protect all enzymatic processes, the function of respiration and the whole distribution of material throughout the body.

Let us return to Cuvier's vortex. Into it let us pour anything, for example hydrochloric acid. No sooner has it entered than it is neutralized, and neutralized it remains until, on leaving the body, it appears as sodium chloride, ammonium chloride and a slightly heightened excess of acid phosphate over alkaline phosphate in the urine.

The urine is variable, the ingesta are variable, even the products of metabolism are variable; but, while life endures, the dynamical equilibrium of hydrogen and hydroxyl ionizations persists.

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[8] For a larger survey of this whole subject two articles in the *Ergebnisse der Physiologie*, VIII., 254, 1909 (the author) and XII., 393, 1912 (Sörensen) may be consulted.

THE PHYSIOLOGICAL SIGNIFICANCE OF SOME SUBSTANCES USED IN THE PRESERVATION OF FOOD[1]

FOOD preservatives are those substances which delay or prevent the decomposition of food as a result of the action of bacteria or other ferment-producing organisms. Other substances, sometimes classed as preservatives, and in the popular mind associated with them, are not so much preservatives as agents for the conservation of some special property of the food in question, as, for example, the use of copper sulphate in the fixation of the color of green vegetables. A large number of bodies may be included under the head of preservatives, but our interest to-day centers in the so-called "artificial" or "chemical" preservatives, because of the question of the permissibility of using them. Some of these bodies have been condemned largely because of their origin, because of their artificial character, which basis of condemnation can not be regarded as sufficient or scientific.

Their merits or faults must be decided on the basis of physiological behavior, essentially, and from this point of view I wish to speak of several substances concerning which the discussions have been

[1] A paper read before the Fifteenth International Congress on Hygiene and Demography, Washington, September 23, 1912.

the most heated. These discussions will be necessarily brief.

SODIUM BENZOATE

On certain phases of the behavior of sodium benzoate there is an abundant literature. Following the pioneer investigations of Meissner and Shepard, and Bunge and Schmiedeberg on the synthesis and estimation of hippuric acid it was recognized that benzoic acid, cinnamic acid, quinic acid and other bodies are normally combined in the animal organism with glycine and excreted as hippuric acid. It was shown, also, that many aromatic fruits and vegetables contain these organic acids which go into the benzoyl combination. Numerous later studies have shown the extent of the glycine, or potential glycine, available in the human body for combination.

With the recognition of this normal character of the hippuric acid synthesis no great objection was raised to the administration of large doses of the benzoate in certain diseases, and going back some thirty years we find a considerable record of clinical experience on the dosage of benzoates in pulmonary tuberculosis, rheumatism and diphtheria. It was shown by many physicians that doses of 5 to 25 grams a day might be given without apparent harm to the patient. This extended experience was sufficient to show that the toxic effect of the benzoate was of a very low order, not much greater possibly than that of sodium chloride.

At the time when sodium benzoate was considered important therapeutically the question of its use as a food preservative had not arisen, and the interest attaching to it then and through the following discussions was in no wise influenced by the present practical question. To what extent may benzoic acid be combined or detoxified in the animal organism? The earlier observers soon recognized that ordinarily and normally it combines with glycine to form hippuric acid, and the question of the available supply of this amino acid was discussed for a long time. In 1898, in experiments on rabbits, Wiener[3] concluded that while large doses of benzoic acid, about 1.7 gram per kilogram of body weight, were usually fatal, smaller amounts and up to the quantity yielding 1 gram of hippuric acid per kilogram of body weight, were combined and detoxified. He believed that the value for the combined benzoic acid, that is, the hippuric acid, was rather constant, the maximum being the 1 gram per kilogram of weight. The usual figures were between 0.7821 and 0.8345 gram per kilogram. From this he concluded that the available supply, or stored-up glycine, must amount to 0.3276 to 0.3496 gram per kilogram of weight. He observed that free benzoic acid appeared in the urine when amounts in excess of the maximum values quoted were ingested.

These observations were made at a time when glycine was looked upon as an important intermediary product of protein metabolism, and before much was known concerning the quantitative relations of the amino acids in the protein molecule. It was later shown that the mean glycine content of the ingested proteins is not far from 4 per cent. of their weight, and that the benzoic acid combined to form hippuric acid may be far greater than the weight corresponding to this glycine content. A stored-up reserve of glycine was for a time assumed to account for the remarkable hippuric acid formation reported by several observers, but this view has been pretty generally abandoned. In this connection the researches of Parker and Lusk,[4]

[3] *Schmied. Arch.*, 40: 313.

[4] *Am. Jour. Phys.*, 3: 472.

Wiechowski,[4] Cohn,[5] Magnus-Levy,[6] Lewinski[7] and others, should be referred to. All of these observers found that in the increased ingestion of large amounts of benzoic acid in animals there was an increased protein metabolism, with increasing amounts of the benzoic acid not combined as hippuric acid. In the Lewinski investigations rather large weights of benzoic acid, as the sodium salt, were given to men. In one case a man of 59 kilograms weight took 12 grams of the acid in 12 hours. All was excreted in combined form and no increase of reducing substances in the urine was noted. This amount of acid is nearly one fifth of a gram per kilogram of body weight, and is relatively less than was ingested in many of the animal experiments. If all combined with glycine it would call for 7.38 grams of the latter, or the glycine existing in about 200 grams of mixed proteins. This amount is probably more than was metabolized in the individual in question.

In another case of Lewinski's a man weighing 67 kilograms took 20 grams of the acid in 12 hours. The urine examination showed the same result as in the other case. Later, the same man took 25 grams of the acid, but it was not all combined, as 1.65 grams were recovered from the urine. When the ingestion was increased to 40 grams still more appeared in the urine uncombined with glycine. In one case on the 40-gram dosage nausea and headache were noted, but these effects seemed less marked with a diet rich in protein. The author concludes that on a high protein diet more benzoic acid may be ingested without ill effects. In one case a man took 50 grams without apparent disturbance, but over 8 grams appeared in the urine uncombined.

All these experiments demonstrate that in man, as well as in animals, ingested benzoic acid may be detoxified in amounts which much more than correspond to the glycine of protein that may be metabolized normally in the same individual, in the same time. The 20 grams of benzoic acid given in one experiment, and which left no free acid in the urine, would correspond to 12.3 grams of glycine.

These papers have been cited because they show the remarkable capacity of the animal organism for the synthesis of hippuric acid and consequent disposition of ingested benzoic acid. It has been shown that the combining power of glycine is not limited to that preformed, or which may be split off in the ordinary metabolism, but that in addition the potential glycine of other amino groups is also available.

It may be urged that this diversion of potential glycine from more complex acids is in itself an abnormal action, and therefore objectionable. This is possibly true, and would have weight, if we were concerned with the question of ingesting daily 5 grams or more of benzoic acid. But the amounts to be practically considered are so far below this that the question of breaking down extra protein does not come to the front at all.

What amounts of benzoic acid are actually in question here? Practically below 500 milligrams daily, if we consider the ordinary solid or semi-solid foods, or below a gram a day, if we consider certain beverages sometimes treated with benzoate. These are probably extreme figures, as for the great majority of food substances benzoate is not used or in any sense required. What then is the physiological behavior of these small amounts of benzoic acid which

[4] *Hofmeister's Beitraege*, 7: 204.

[5] *Jaffe Festschrift*, Braunschweig, 1901.

[6] *Münch. Med. Wochensch.*, 52: 2168; *Biochem. Zeitschr.*, 6: 502 and 523.

[7] *Schmied. Arch.*, 58: 397.

have practical significance? Several lines of enquiry may be followed to find an answer to this question, three of which are comparatively direct: (a) the fate in the body; (b) the action on digestive ferments; (c) the action with reference to general health and metabolism.

(a) With reference to the relations under (a) we have already sufficient information. Small amounts of benzoic acid are completely united with glycine, and for 500 milligrams 307.5 milligrams of the latter are required, an amount far within the liberation from the ordinary protein metabolism. In the cases of infants or invalids with lower metabolism the possible benzoate ingestion is naturally far below this, and there would doubtless be always, even in such extreme cases, a sufficient glycine content for combination.

With no benzoic acid ingested the larger part of the glycine would probably go to form urea and other products by oxidation. With the benzoic acid we have the synthesis of hippuric acid. Unfortunately, we have no reliable means of comparing the magnitude of or the difficulty in the enzymic work in the two cases. In certain quarters much has been said about the over-burdening of the kidneys with this work of synthesis. As a matter of fact there is no warrant whatever in the assumption that the tax on the organism is any greater in this case than in the other, and those who make the assumption probably overlook the fact that the hippuric-acid synthesis in the human body is normal and constant. Because of a lack of delicacy in the methods employed for the determination of hippuric acid the quantity of this substance excreted daily has usually been greatly underestimated, or neglected entirely.

(b) The behavior of benzoic acid toward digestive ferments has been the subject of several investigations. In this direction the action on diastases, pancreatin, pepsin, rennin and the lipases has been studied. A number of such studies have been carried out in my own laboratory, with the general result that while there is naturally an inhibition of digestive activity with certain concentrations of benzoic acid, with those concentrations which have practical importance in the present enquiry the inhibition is very slight or does not appear at all.

In the case of the digestion of starches there is indeed a distinct acceleration in the rate of digestion, as is caused by a number of neutral salts and acids of low concentration. This is true not only of digestions by means of malt infusions, but also in the case of taka-diastase and a number of the pancreatic diastase preparations in general use in this country. Similar results were reported some years ago by Leffmann.[8]

While 0.1 per cent. of sodium benzoate added to egg albumin mixture, such as is used in the official pepsin tests, distinctly retards the rate of digestion, this is not the case with one fifth of this concentration, which is probably above the limit ever found in the stomach after the ingestion of benzoated foods. This relation has been observed in a number of mixtures of fibrin as well as egg albumin, and with a variety of pepsin preparations. Analogous results have been reported by Gerlach in his lengthy study of the benzoate question.[9]

Very weak concentrations of either benzoate or benzoic acid have no influence on the rennin coagulation of milk, but with an increase in the concentration there is a gradual inhibition. Our results in this

[8] *Jour. Frank. Inst.*, 147: 1899, p. 97.

[9] Wiesbaden, 1909.

respect are not essentially different from those of Weitzel.[10] In the clinical feeding of infants sodium benzoate has been frequently added to milk.

According to Amberg and Loevenhart[11] the activity of lipase, as measured by the splitting of ethyl butyrate, is not diminished by the presence of 0.1 per cent. of sodium benzoate. Dakin, working in Herter's laboratory, has made a careful redetermination of many of the digestive constants in presence of benzoate.[12]

(*c*) We now come to the most important part of the subject, the behavior of benzoic acid with reference to general health and metabolism. At the time when this substance was extensively used in medical practise, that is, from 1875 to 1880, it was recognized by some physiologists that large doses were followed by increased elimination of nitrogen, which, it was assumed, must come from the breaking down of body proteins. E. Salkowski, especially, from experiments on dogs,[13] concluded that high doses might occasion a considerable loss in man. But in the dog experiments the ingested benzoate amounted in the mean to about one third of a gram per kilogram of body weight, which proportion if applied to a man of 50 kilograms weight would call for nearly 17 grams of benzoate, or 25 grams for a man of 75 kilograms weight. Somewhat similar observations were made by other physiologists, but on the other hand the reports from clinical practise failed to show any such losses. To follow these discrepant observations farther is not necessary in this place, as the question of the increased nitrogen excretion has been pretty fully handled in the investigations of Magnus-Levy,[14] Ringer, and Epstein and Bookman,[15] and others already referred to.

But these early reports have had one very important effect, which must be recalled here. They left the impression that the ingestion of sodium benzoate is in general followed by increased protein metabolism, tissue metabolism possibly, an undesirable result, and this statement is frequently repeated as applicable to all doses of benzoate. A number of lengthy metabolism experiments have shown that for ordinary ingestions of benzoate this increased protein metabolism does not occur. In the last few years the results of several such investigations have been published. One of these investigations was conducted under the auspices of the Bureau of Chemistry of the United States Department of Agriculture, and from it the conclusion was drawn that small doses of benzoic acid or benzoates exert a harmful action on man, a slight loss in weight being affirmed in some cases. It is not my purpose to criticize this work here beyond saying that the published data do not seem to warrant the conclusions drawn, which opinion is shared in a lengthy review of the work by K. B. Lehmann, recently published.[16]

I wish to speak more particularly of the results of the extended studies carried out by Chittenden, Herter and myself, as members of a commission appointed by the Secretary of Agriculture to investigate the question anew.[17] In Herter's work four men were observed through periods of four months, while in the investigations of Chittenden and myself six men on a definite

[10] *Arbeiten aus dem kais. Gesundheitsamt*, 19: 1902.

[11] *Jour. Biol. Chem.*, 4: 1908.

[12] Herter, *Jour. Am. Med. Assoc.*, 54: 1774.

[13] *Virchow's Archiv*, 78.

[14] *Loc. cit.*

[15] *Jour. Biolog. Chem.*, 10.

[16] *Chemiker Zeitung*, November 28, 1911.

[17] Report No. 88, U. S. Department of Agriculture, 1909.

diet containing sodium benzoate were observed through a period of four months.

These studes covered lengthy observations on the general metabolism of the men, the qualitative changes in the urine, the effects on the blood, effects on the intestinal flora, and daily clinical observations on the weight and general condition of the men. Under the head of metabolism determinations were made of the nitrogen balance and utilization, the distribution of nitrogen, the distribution of sulphur and the utilization of fat. From the data of Chittenden and myself, which were fuller in detail than those of our colleague, certain facts are clearly shown. In Chittenden's series of experiments the doses of benzoate were administered as follows:

	Days	
Fore period	14	no benzoate
Low benzoate period	62	300 mg. daily
After period	10	no benzoate
Medium benzoate period	7	600 mg. daily
First high benzoate period	7	1,000 mg. daily
Second high benzoate period	7	2,000 mg. daily
Third high benzoate period	7	4,000 mg. daily
After period	10	no benzoate
Total	124	71.8 grams

This is an average dosage of 718 milligrams daily, for dosage periods. In my series of experiments the amounts were as follows:

	Days	
Fore period	25	no benzoate
Low benzoate period	60	300 mg. daily
Medium benzoate period	14	600 mg. daily
High benzoate period	18	1,000 mg. daily
After period	7	no benzoate
Total	124	44.4 grams

This is equivalent to an average dosage of nearly 483 milligrams daily for the dosage periods. In either case the dosage more than covers the practical consumption and is doubtless better adapted to throw light on the subject than are the excessive doses previously given. Larger ingestions of benzoate are no more suited to prove its practical physiological action than would 150 grams of sodium chloride, kilograms of sugar or half liters of vinegar daily be suitable for these substances. With such large ingestions even the common food substances or condiments might be made to appear highly injurious.

Time will not permit me to go into details with reference to all these experiments. It is sufficient to say that no effects whatever were observed which pointed to a modification of the nitrogen or fat utilization, the nitrogen balance or distribution, the sulphur metabolism, the body weight or the hemoglobin content and red and white counts in the blood. The order of nitrogen distribution remained always the same in the period averages, and it was only when doses of 4 grams of benzoate daily were given that Chittenden noticed a slight, but to be expected, percentage decrease in the urea excretion.

Qualitative Changes in the Urine.—In all of our work frequent examinations were made for the appearance of sugar or other reducing bodies, traces of albumin, casts, aromatic oxyacids, or other things which might indicate a change in the nature of the excreted bodies. There was never any indication of an alteration in this direction. The occasional appearance of a trace of albumin or of a hyaline cast was no more frequent in the dosage periods than in the fore periods, and was without practical significance.

During the progress of the work frequent determinations were made of the so-called normal reduction of the urine of the men working in my laboratory, by means of a delicate ammoniacal copper solution. No definite changes were noted which could be connected in any way with the benzoate. After the conclusion of the 124 days of

regular experimentation two of the men in my group who had followed the regular routine continued for seven days longer, with higher dosage. They began with 5 grams a day and finished with 10 grams, the average being 7.5 grams daily. With this large dosage there was no reduction which could be noticed with Fehling solution, and nothing which was outside the normal limits for the ammoniacal solution, although there appeared to be a slight increase from the former figures. Other changes were absent. A third man who had not been a member of the experimental squad, but who had followed the same diet routine, took doses beginning with 5 grams and ending with 7.5 grams on the seventh day. No abnormal behavior of any description was noted in his excretion or general condition. In this case it could not be urged that the man had become accustomed to large doses through gradually increasing small doses.

Temperature, Pulse, Respiration.—All these factors were systematically noted from day to day for each man. Absolutely no variations from the normal were observed which might in any way be attributed to or connected with the dosage of benzoate.

Conclusions.—From all these observations the conclusion was drawn that in the dosage administered, which is large enough for practical purposes, sodium benzoate exercises no recognizable physiological action on the human organism, beyond the slight increase in hippuric acid excretion, a change which is often exceeded after hearty meals of certain berries and fruits which are frequently consumed in quantity. I have recited the facts in some detail because of the long-continued and persistent attempts to create the impression, especially in this country, that sodium benzoate exerts a toxic action, sufficiently marked to warrant its exclusion from use with foods.

Gerlach's Studies.—Attention must be called here to an elaborate investigation carried out by Dr. Gerlach, of Wiesbaden, on the effects of sodium benzoate as used in the food industries. These experiments were continued through a long period and appear to have been conducted with great care. From the numerous clinical and metabolism observations made Dr. Gerlach draws the conclusion that sodium benzoate causes no changes in the body which may be considered as harmful, or which may be taken as pointing to departure from the normal in any direction.[18]

COPPER SALTS

It has long been a popular notion that copper salts are decidedly toxic and the older medical literature contains many references to poisoning by verdigris and other combinations of copper. Modern study, however, has shown that these assumed effects were greatly exaggerated. The subject has practical interest now because of the custom, which had its origin in France, apparently, of fixing the color of certain green vegetables by cooking them in the canning process in contact with small amounts of copper sulphate, or other copper salt. The effect depends on the formation of a very stable green compound of copper and a derivative of chlorophyll.

The permissibility of the process has been much debated, especially in France, Germany and Belgium. In France the discussion has been a prolonged one and several scientific commissions have taken part in it. Some of the older commissions made reports finding against the use of

[18] Dr. med. V. Gerlach, "Physiologische Wirkungen der Benzoesaeure und des benzoesauren Natron," Wiesbaden, 1909.

copper in this way, but in the more recent studies the results seemed to point to the practical harmlessness of the metal in green peas and beans. In consequence of these French investigations, and later ones in Germany, the use of copper in limited amounts is now tolerated by the food laws of most European countries.

There seems to be no question regarding the physiological action of relatively large amounts of copper salts. They behave as irritant poisons and produce nausea, vomiting, purgation, while the small quantities absorbed exhibit characteristic lesions in the liver, spleen, kidneys and other organs. We are concerned, however, with amounts far below those necessary to cause any such violent symptoms, amounts which could scarcely exceed 15 to 20 milligrams of copper daily in any case, and usually much below this. In the coloring of peas and beans the amount of sulphate used is generally less than 1 gram per kilo, a part only of which becomes fixed in the product, the actual copper content being from 25 to 150 mg. per kilo, ordinarily.

What are the effects of small doses, up to 20 milligrams of copper daily? To answer this question experiments have usually been made with the sulphate or other soluble salt, but it should be recognized that this does not exactly correspond to the practical situation, since in the pea or bean the copper is largely combined as phyllocyanin compound, which in its solubility is very different from the ordinary salts, and is much more stable.

The results of a long series of experiments carried out in my laboratory in the last two years have convinced me that the copper perfectly combined in this chlorophyll derivative is practically without any evident physiological action in amounts up to 12 or 15 milligrams daily, which amounts would be contained in a weight of the vegetable as large as any one could eat with a relish for more than a short period. There appears to be no effect on body weight, nitrogen metabolism, blood factors or qualitative or microscopic blood findings. Nausea is not produced. But the case is somewhat different when we turn to small doses of copper salts given in tea, coffee, milk or beer. Here in time we notice some effect, especially in causing nausea and digestive disturbances, and also in some cases a slight modification of the nitrogen partition and some of the blood factors.

In young vegetables with high chlorophyll content the copper sulphate used in small amount appears to be very perfectly combined. This compound is remarkably stable and resists the action of the digestive ferments to a degree which prevents any great absorption of the copper. In the case of the green pea especially the chlorophyll is largely in the hulls, and these, still green with their copper compound, may pass through the alimentary tract and be found in the feces but little changed. This copper-chlorophyll complex is but slowly broken up by hydrogen sulphide or ammonium sulphide.

In older vegetables, however, where the chlorophyll has become considerably destroyed this copper compound can not be formed to the same extent and the copper added in the canning operation goes into a union with proteins which is easily broken down. In this case the copper acts much as it does in the ordinary inorganic salts. In experiments I have found it possible to add 250 to 300 milligrams of copper per kilo to old green peas, and others have reported still higher additions. Much of this copper may be separated easily by dilute hydrochloric acid.

The fact that the non-ionic copper in the phyllocyanate is practically inert physiologically has been noticed by others. Reference here may be made to the work of Tschirsch,[19] Spiro[20] and Brandl.[21] These writers agree that other compounds of copper have a much more marked effect. From these other combinations, as well as from imperfectly coppered vegetables, the metal may reach the liver and other organs and in time produce a marked effect. In a series of experiments by Chittenden this absorption has been clearly shown. As long as it is not practically possible to limit the use of copper in greening to the youngest vegetables only, and in a specified small amount, it would seem that it might be well to prohibit its use altogether in foods, where, indeed, it serves no useful purpose beyond imparting a bright green color.

SULPHUROUS ACID

Sulphurous acid is used in two essentially different ways in the treatment of food products. First, in the free state or the oxide, and secondly, as a salt, usually sodium sulphite, but sometimes the bisulphite. Some years ago there was for a time a limited application of the true hyposulphite, but this seems to have been abandoned. Sulphurous acid found its first uses in this connection in the protection of must before fermentation, and in the racking off or transfer of wines from one vat to another, or just before bottling. These uses are still in vogue, and other uses have been introduced, especially in the clarification of cane juices before boiling down for sugar, and in the treatment of certain fruits in the sun-drying process. Within comparatively recent times the application of sodium sulphite in some of the minor meat industries and in the canning of certain vegetables was introduced.

It will be seen at a glance that we have here two rather distinct conditions. In the application of the sulphurous acid in the sugar, wine and fruit industries there is finally a pretty complete combination of the product with the sugars to form the aldehyde compounds, from which the sulphite is gradually oxidized. These carbohydrate-containing substances hold also certain organic salts, the acids of which are in part displaced by the sulphurous acid. The protein and fatty substances of meats, however, are in themselves inert toward sodium sulphite, and the latter remains unmodified or combined. The fats, in addition, protect the sulphite from rapid oxidation. Among food chemists there seems to be a practical recognition of this distinction in the active condition of the two classes of sulphured products, and the question of permissibility of use has been advanced generally with reference to the sulphites, rather than as concerns the carbohydrate combinations.

As observed with relatively large ingestions all these products exert, of course, a somewhat toxic action, and the toxicity of the carbohydrate combinations seems to run parallel with their rates of dissociation as aldehyde compounds. For the pure aldehydes the rate is rather rapid in the glucose compound, as the lengthy investigations carried out by Rost and Franz and by Kerp have shown.[22] But in their experiments the rate of dissociation of the glucose aldehyde compound is undoubtedly far greater than would be the case in the commercial combinations of fruits and

[19] "Das Kupfer vom Standpunkte der gerichtlichen Chemie, Toxikologie und Hygiene," Stuttgart, 1893.

[20] *Muench. Med. Wochenschr.*, 56: 1, 1070.

[21] *Arb. aus dem kais. Gesundheitsamt*, 13: 104, 1897.

[22] *Arb. aus dem kais. Gesundheitsamt*, 21: 1904.

syrups, for example, where there is always a great protecting excess of the sugar present. In most of the experiments carried out to test the pharmacological action the dosage of the sulphur compound has been so relatively large as to render difficult a conclusion regarding the behavior of small doses, or those which have practical importance. This is especially true of the experiments of Kionka frequently quoted.[23]

In Lehmann's experiments on dogs and cats, with doses running up to 37.5 and 62 milligrams of sulphurous oxide (150 to 250 milligrams of sulphite) daily, and extending through about 200 days, no definite harmful effects were seen. Lehmann considered these doses relatively large.[24]

I can refer but briefly to the work of two recent French commissions which have studied the behavior of sulphurous acid in wine, with respect to the health of the consumer. As a result of these investigations an official announcement was made about a year ago in France, advancing the allowable content of sulphurous oxide in wine from 350 to 450 milligrams per liter, of which not over 100 milligrams may be in the free state. I have not heard that this tentative standard has been modified.

This whole question is now under review by the commission appointed by the Secretary of Agriculture of this country, but the lengthy investigations undertaken have not yet been brought to a conclusion, and can not, therefore, be discussed here.

JOHN H. LONG

THE THOMAS PENNANT COLLECTION

SINCE the death of Gilbert White's correspondent, Thomas Pennant (1726–1798), the author of "British Zoology," "A Tour in Scotland, Wales and Ireland," and other important works, the collections made by him have remained almost as he left them, at Downing Hall, Holywell, Flintshire. This estate, with the collections, was inherited by a former Countess of Denbigh, and the present owner, the Earl of Denbigh, C.V.O., being about to dispose of it, has presented the whole of the Pennant Collection to the trustees of the British Museum. Accompanying the Collection are several volumes of a manuscript catalogue in which the specimens were, for the most part, entered and numbered. A fairly large proportion of the specimens still bear numbers corresponding with those in the Catalogue, a very fortunate circumstance, since most of the labels that have been preserved had become dissociated from the specimens to which they referred. The Catalogue is accompanied by letters and lists from several of Pennant's distinguished correspondents. Among the 140 birds are the only two known specimens of the extinct British race of capercailzie, as well as the originals of many birds figured in the "British Zoology" (1766). There are also a few mammals, fishes and crustaceans. The recent shells include 16 type-specimens and 70 figured specimens, all described in the "British Zoology." The fossils run to more than 1,000 specimens and include many from foreign localities presented by the Italian naturalist, Allioni, and others. Three of the British Silurian corals were described by Pennant in 1757, and a mammoth tooth from Flintshire was referred to by him in 1771. Of minerals there are about 860 specimens, of which 340 still retain their original labels. Pennant appears to have begun this section of his collection when he visited the Rev. William Borlase, author of "The Natural History of Cornwall," and from him he received specimens from time to time. Other donors were Bishop E. L. Pontoppiden, author of "The Natural History of Norway," and Emannuel Mendes da Costa, author of "The Natural History of Fossils" (1757). Among the Welsh minerals the most important are those from Flintshire which formed the basis for the description of Flintshire minerals published in "The Tour in Wales" (1778). Additions to

[23] *Arch. Hygiene*, 22: 1896.

[24] *Arch. Hygiene*, 66: 303, 1909.

the mineral series were also made by David Pennant, the son of Thomas. Interesting portions of the collection have already been placed on exhibition at the Natural History Museum; but every specimen is to be carefully preserved, and it may be hoped that in course of time the Museum experts will be able to identify yet other specimens of historical importance.

Thomas Pennant was one of the best known naturalists of his day. At an early age he was in correspondence with Linnæus. Buffon, whom he visited in Burgundy, utilized the "History of Quadrupeds." Cuvier, in the "Biographie Universelle," spoke of that work as "encore indispensable," and further accorded high praise to the "Arctic Zoology."

THE POPULATION OF NEW YORK STATE

THE composition and characteristics of the population of New York, as reported at the Thirteenth Decennial Census, are given in an advance bulletin soon to be issued by the Bureau of Census, Department of Commerce and Labor. Of the total population of New York, 3,230,325, or 35.4 per cent., are native whites of native parentage; 3,007,248, or 33 per cent., are native whites of foreign or mixed parentage; 2,729,272, or 29.9 per cent., are foreign-born whites; and 134,191, or 1.5 per cent., are negroes. The corresponding percentages in 1900 were 39.2, 33.2, 26 and 1.4, respectively, the proportion of foreign-born whites having increased during the decade. In 35 of the 61 counties the percentage of foreign-born whites is less than 15; in 18 it is between 15 and 25; in 6 it is between 25 and 35, and in 2, New York and Kings, it is 35 or over. Of the 2,762,522 inhabitants of New York County, 45.4 per cent. are foreign-born whites and only 15.8 per cent. are native whites of native parentage. In 23 counties the percentage of native whites of foreign or mixed parentage exceeds 25, being 42.6 in Queens, 41.5 in Erie, and 40.6 in Kings. Of the urban population, 27.2 per cent. are native whites of native parentage; of the rural, 66.1 per cent. The corresponding proportions for native whites of foreign or mixed parentage are 36.5 and 19.9 per cent. respectively. The percentage of foreign-born whites is 34.5 in the urban population and 12.8 in the rural.

In the total population of the state there are 4,584,597 males and 4,529,017 females, or 101.2 males to 100 females. In 1900 the ratio was 98.9 to 100. Among native whites the ratio is 97.5 to 100, and among foreign-born whites 110.5 to 100.

Of the total native population—that is, population born in the United States—88.7 per cent. were born in New York and 11.3 per cent. outside the state; of the native white population, 10.4 per cent. were born outside the state, and of the native negro, 59 per cent. Persons born outside the state constitute a larger proportion of the native population in urban than in rural communities.

Of the foreign-born white population of New York, persons born in Russia represent 20.5 per cent.; Italy, 17.3; Germany, 16; Ireland, 13.5; Austria, 9; England, 5.4; Canada, 4.5; Hungary, 3.5; Sweden, 2; all other countries, 8.4. Of the total white stock of foreign origin, which includes persons born abroad and also natives having one or both parents born abroad, Germany contributed 21.5 per cent.; Ireland, 19; Russia, 14.8; Italy, 12.9; Austria, 6.7; England, 6; Canada, 4.7; Hungary, 2.5; Scotland, 1.6; Sweden, 1.6 per cent.

Of the total population, 9.9 per cent. are under 5 years of age, 17.4 per cent. from 5 to 14 years, inclusive, 19.5 per cent. from 15 to 24, 32.5 per cent. from 25 to 44, and 20.6 per cent. 45 years of age and over. The foreign-born white population comprises comparatively few children, only 7 per cent. of this class being under 15 years of age, while 73.6 per cent. are 25 years of age and over. Of the native whites of foreign or mixed parentage, 38.3 per cent. are 25 and over, and of the native whites of native parentage, 49 per cent. The urban population shows a larger proportion of persons in the prime of life than the rural and a smaller proportion past middle age. Migration to the city and the influx of foreign immigrants explains this, at least in part. Of the urban population, 33.6 per cent. are from 25 to 44 years of age, inclusive, and

of the rural population, 28.3 per cent., while the percentages 45 years and over are 18.3 and 28.7, respectively. The large number of children in families of foreign origin may account for the fact that the proportion of children under 5 is greater in the urban population than in the rural.

The Census Bureau classifies as illiterate any person 10 years of age or over who is unable to write, regardless of ability to read. There are 406,020 illiterates in the state, representing 5.5 per cent. of the total population 10 years of age and over, the percentage being the same as in 1900. The percentage of illiteracy is 13.7 among foreign-born whites, 5 among negroes, and 0.8 among native whites. For all classes combined, the percentage of illiterates is 5.9 in urban communities and 3.9 in rural, but for each class separately the rural percentage exceeds the urban. For persons from 10 to 20 years of age, inclusive, whose literacy depends largely upon present school facilities and school attendance, the percentage of illiteracy is 2.1.

In the population 15 years of age and over 39.8 per cent. of the males are single and 33.7 per cent. of the females. The percentage married is 55.2 for males and 54.5 for females, and the percentage widowed is 4.4 and 11.3 respectively.

SCIENTIFIC NOTES AND NEWS

The council of the British Association for the Advancement of Science has nominated Sir Oliver Lodge to be president for the Birmingham meeting in place of the late Sir William White.

A portrait of Sir William Turner, K.C.B., principal and vice-chancellor of Edinburgh University and professor of anatomy from 1867 to 1903, has been presented to the university. The portrait is the work of Sir James Guthrie. The ceremony took place in the library of the old university, Mr. Balfour, chancellor of the university, presiding. Sir Robert Finlay, K.C., M.P., made the presentation and Mr. Balfour accepted the portrait on behalf of the university.

Dr. E. W. Hilgard, emeritus professor of agriculture at the University of California, is recovering from severe injuries received a few weeks ago, when a flight of steps which he was ascending gave way, throwing him to the floor. The broken bones are uniting and it is hoped that he will soon be able to resume his writing, which was interrupted by the accident.

At the ceremonies connected with the opening of the Phipps Psychiatric Clinic of the Johns Hopkins University Hospital, beginning on April 16, addresses will be given by Sir William Osler and Professor William McDougall, of Oxford; Frederick W. Mott, F.R.S., of London; Professor Heilbronner, of Utrecht; Professor Bleuler, of Zurich, and Professor Orovino Rossi, of Italy.

On the nomination of the council of the University of Paris, M. Jean Perrin, professor of physical chemistry in the University of Paris, has been appointed visiting French professor at Columbia University for 1913–14.

Sir Cecil H. Smith, director of the Victoria and Albert Museum, and Dr. E. H. Starling, F.R.S., professor of physiology in the University of London, have been elected members of the Athenæum Club, London, under the rule which empowers the annual election of three persons "of distinguished eminence in science, literature, the arts, or for public service."

At the dinner of the Chicago Medical Society on February 26 Dr. Abraham Jacobi, New York City, and Dr. Edward Martin, Philadelphia, were the guests of honor.

A reception was given by the Manhattan Medical Society on February 28 to Dr. Jacques Loeb, of the Rockefeller Institute, at which he spoke on "Some Recent Experiments in Artificial Parthenogenesis."

Mr. John J. Schoonhoven, president of the department of zoology of the Brooklyn Institute, has been made a fellow of the institute.

The Rev. A. H. Cooke, known for his work on molluscs, has succeeded Mr. R. Bullen Newton as president of the Malacological Society of London.

MR. FRANK ARMITAGE POTTS, M.A., fellow of Trinity Hall, Cambridge, has been elected to the Balfour studentship.

MR. T. LL. HUMBERSTONE, B.Sc., has been appointed to the Mitchell studentship of the University of London. The studentship, which is of the value of £100, is for the study of some definite feature of business or industrial organization at home or abroad. Mr. Humberstone proposes to investigate the scheme of industrial fellowship in the Universities of Pittsburgh and Kansas under which research work in applied science is promoted with funds provided by, and to some extent under the supervision of, industrial and commercial organizations.

PROFESSOR WILLIAM MCPHERSON, dean of the graduate school and professor of chemistry at the Ohio State University, has been granted leave of absence for the second semester of the current year. He sailed on March 1 for Germany, where he will spend the next six months in research work in chemistry.

MR. LUTHER E. WIDEN, of the University of Iowa, will accompany Mr. Villjalmar Stefansson on his expedition and will make psychological measurements on the Esquimaux.

PREPARATIONS are being made for the despatch of an official French expedition to Franz Josef Land under M. Jules de Payer, son of the Austrian Captain de Payer, who commanded the Austrian expedition that discovered Franz Josef Land in 1873.

MR. ANDERS K. ANGSTRÖM, son of the distinguished Swedish physicist, and now a student at Cornell University, will have charge of a scientific expedition to Mt. Whitney to continue work on the radiation of the sun under the Smithsonian Institution. Mr. Angström was assistant to Dr. C. G. Abbot, director of the Smithsonian Astrophysical Observatory, in his work in Algeria last summer.

PROFESSOR FRANK SMITH, of the zoological department of the University of Illinois, has been requested by the authorities of the United States National Museum at Washington to take charge of its collection of annelid worms belonging to the group of Oligochæta. Professor Smith and his assistants are now at work on the anatomical study and classification of the first installment of material, which includes not only North American forms, but also part of the collection made a few years ago by the Roosevelt expedition to East Africa. The remainder of the material in the possession of the national museum will be sent to Urbana as it is needed.

DR. FELIX KRUEGER, professor of philosophy at the University of Halle and Kaiser Wilhelm professor at Columbia University, lectured on psychological subjects last week at the University of Wisconsin and the University of Illinois.

PROFESSOR W. M. DAVIS, during his recent trip to the middle west, lectured at Oberlin College and the University of Chicago on "Dana's Confirmation of Darwin's Theory of Coral Reefs," and before the Sigma Xi Society of Northwestern University on "Human Response to Geographical Environment"; he also spoke at the Francis W. Parker School, Chicago, on "The Highlands of the Rocky Mountains in Colorado."

THE winter course in highway engineering (February 24 to March 8), given this year for the first time at the Ohio State University, has proved to be popular with the engineers of Ohio who are engaged in highway construction. Contractors, inspectors and county commissioners to the number of sixty enrolled for the course. The Ohio Good Roads Federation cooperated with the university in meeting the expense. The lectures covered many phases of highway construction, maintenance and materials. Among the special lectures were Professor A. H. Blanchard, of Columbia University; A. N. Johnson, state highway engineer of Illinois, and J. J. Voshell, U. S. highway engineer, Washington, D. C.

THE fifth annual meeting of the Illinois Water Supply Association was held at the University of Illinois on March 11 and 12. Members of the association are interested in obtaining and conserving an abundant supply of pure water in the state of Illinois. Special

exhibits are to be placed in the hydraulic and the state water survey laboratories. Among the speakers announced were: Dr. E. O. Jordan, professor of bacteriology, University of Chicago; Dr. W. L. Lewis, professor of chemistry, Northwestern University; Dr. S. A. Forbes, professor of entomology, University of Illinois, and others from these universities, and water supply experts from Chicago, London, England, Charleston, S. C., Cincinnati, Ohio, Washington, D. C., and many other large cities.

DR. E. C. JEFFREY, professor of plant morphology at Harvard University, lectured at the University of Illinois last week on the formation of coal.

DR. ALBERT ERNEST JENKS, professor of anthropology, University of Minnesota, delivered five illustrated lectures on the "Philippine Peoples," in New York City, for the Board of Education during the recent intersemester recess.

ON the evening of March 6, Professor A. W. Goodspeed, of the University of Pennsylvania, lectured before the Franklin Institute on "The Relation of Electricity to Matter."

PROFESSOR GEORGE GRANT MACCURDY, of Yale University, lectured before the Science Club of Amherst and the Massachusetts Agricultural College on the evening of March 3, the lecture being based on his past summer's work in the European prehistoric field.

ON February 28, Dr. L. R. Ingersoll, of the physics department of the University of Wisconsin, gave an address on the "Kerr Effect" before the physics colloquium at the University of Illinois.

DR. JOHN SHAW BILLINGS, director of the New York Public Library since 1896, previously professor of hygiene at the University of Pennsylvania, surgeon and lieutenant colonel in the army, died on March 10, aged seventy-three years.

OSCAR DANA ALLEN, professor of metallurgy and analytical chemistry at Yale University from 1871 to 1887, died on March 5 at his home at Ashford, Wash. He had written on the flora of Mount Tacoma.

PROFESSOR OSCAR OLDBERG, dean emeritus of the Northwestern University School of Pharmacy, for thirty years a member of the committee of revision of the United States Pharmacopœia, died in Pasadena, Cal., on February 27.

DR. ARNOLD HELLER, professor of pathological anatomy at Kiel, has died at the age of seventy-three years.

THE Pagel collection of books on the history of medicine, being the library of the late Professor Julius Pagel, has been given to the medical department of Washington University through the generosity of a friend of the institution. The library contains about 2,500 titles.

A MEETING of the committee appointed to make arrangements for the meeting of the British Association in Birmingham in September was held on March 10, Alderman W. H. Bowater presiding. The Finance Subcommittee reported that promises amounting to £5,493 by 642 local people had been received in answer to the circular sent out to 3,000 persons in January. Sir Oliver Lodge mentioned that the local fund would pay the greater part of the expenses of the meeting, and that the membership subscriptions and general receipts for admission would go into the general funds of the British Association for the assistance of scientific research. Professor Gamble, on behalf of the Halls Committee, said it had been arranged to have the president's address and the evening meeting at Central Hall, while the offices, reception rooms and refreshment rooms would be at the Town Hall and Mason College.

ON the occasion of the seventeenth International Congress at London next August, three prizes will be awarded: The Prize of Moscow, commemorating the twelfth congress, of the value of 5,000 francs, will be awarded for work in medicine and hygiene or for eminent services rendered to suffering humanity; the Prize of the thirteenth Congress of Paris, having a value of 4,000 francs, will be bestowed for original work during the past ten years bearing upon medicine, surgery, obstetrics or the biological sciences in their

application to medical science; and the Prize of Hungary, instituted to commemorate the sixteenth Congress of 3,000 crowns, will be given for a notable piece of work in medical science which has appeared in the interval since the last congress. Nominations of candidates for these prizes are invited before June 1, 1913, and should be sent, together with examples of the work on which the candidacy is based, to the Bureau de la Commission permanente des Congres internationaux de medicine, Hugo de Grootstraat 10, The Hague.

THE Southern Society for Philosophy and Psychology will hold its eighth annual meeting at the Johns Hopkins University, Baltimore, on April 8 and 9.

THE annual meeting of the American Breeders' Association was held at Columbia, South Carolina, in affiliation with the National Corn Exposition, January 24–27, 1913. As usual in recent meetings of this association, the work of the eugenics section was especially prominent. Dr. Charles B. Davenport's evening lecture to the citizens of Columbia on eugenics and the colored race was received with interest. He gave a general view of the difficulties brought about by the blending of the unit characters of two races so radically different. A feature of the work of the plant section was a visit to the state experiment station booths at the National Corn Exposition, which is really a national farm crops exposition. A plant-breeding expert in each of nearly a dozen states received the association at his booth and with samples at hand told of one or more varieties of corn, wheat, sugar cane, or other crop which had been materially improved by the state experiment station and had come into wide commercial use in the state. In each case the method of breeding used in producing the new variety, the percentage of increase it produced over the varieties it is displacing and the acreage covered throughout the state were given. For example, a variety of sugar cane in Louisiana was said to now occupy half the sugar cane area of that state with a yield of canes ten per cent. above the yields of varieties it displaced and with a percentage of sugar in these canes ten per cent. above the old averages. Nearly similar increases were shown in varieties of wheat in Minnesota and Washington, varieties of corn in Indiana, Illinois and other states and varieties of cotton in South Carolina and other southern states.

UNIVERSITY AND EDUCATIONAL NEWS

BY the death in Wallingford, Conn., of Joseph Lyman, Yale University will receive \$650,000. He held the life use of that sum which was willed to the college by his brother, Samuel Lyman, who died in 1910.

BOTH houses of the legislature of the state of Washington recently adopted the biennial budget submitted by the joint appropriations committees. The University of Washington will receive \$1,004,701. The matter of the replacement of the temporary university buildings by adequate modern structures has been submitted to the legislature separately.

THE recently adjourned legislature of West Virginia gave larger appropriations to the state university than in any previous year. Among others was a special appropriation for the medical work to make it possible to follow out the plans outlined by the committee from the Association of American Medical Colleges.

THE Indiana legislature has made an appropriation of \$65,000 for the medical school and hospital of the Indiana University School of Medicine for the first year, and an annual appropriation of \$75,000 thereafter.

FUNDS have been provided at Columbia University to build a laboratory for the study of cancer under the George Crocker research fund. This fund amounts to over one and one half million dollars, and it was provided that the income should be used solely for research work. The laboratory, which will be 100 by 40 feet and three stories high, will be on the block east of Amsterdam Avenue on 116th St.

THE clinical and laboratory building of the Stanford University Medical Department in San Francisco has recently been remodeled at an expense of about \$40,000. This large building was formerly used by Cooper Medical Col-

lege and had in it, besides the Lane Hall, a number of amphitheaters and lecture rooms, and the Lane Medical Library. With the removal of the Lane Medical Library to its new building across the street and with the shifting of laboratories and the rearrangement of the space formerly occupied by Lane Hall, considerable additional space has been gained for the outpatient clinics and laboratories. The lower floor of the building is devoted entirely to the surgical outpatient clinic, the surgical specialties and the history room and drugstore, the second floor to the medical outpatient clinic and the clinics of pediatrics, neurology and dermatology. The three upper floors are devoted to the pathological museum and the laboratories of experimental medicine, pathology, pharmacology and experimental surgery. Reading rooms have been provided for the students in close connection with the clinical laboratory. This laboratory and the outpatient department are separated by only a short corridor from the clinical wards of Lane Hospital so that both in- and outpatient material is equally available for purposes of teaching. The front part of Lane Hall has been converted into a modern amphitheater suitable for demonstrations. About 12,000 patients were received by the outpatient department during the past year with a total number of visits of over 60,000.

A BILL to establish a college of medicine and dentistry at the Ohio State University is now before the state legislature and has passed the senate. If it becomes a law, the Starling Ohio Medical College of Columbus will be transferred to the state and become the basis of the new college.

CAPTAIN C. E. MARSH, U. S. N., has made public the details of the plan for giving a number of college undergraduates an opportunity to take a summer cruise on some of the navy vessels and thus to familiarize themselves with life on board ship and fit themselves to become members of a sort of naval reserve. The college students will be assigned in squads of 20 to each ship, and as far as possible men from the same college will be kept together.

THE Prussian minister of education has announced that fees at Prussian universities for foreign students will be doubled. Russian students will hereafter be required to be graduates of gymnasia. There has been agitation in Germany recently in regard to foreign students, the University of Munich having limited the number to three per cent. There are at present 5,196 foreigners studying at the German universities, of whom 338 are Americans.

THE 126th anniversary of the granting of the first charter by the legislature of Pennsylvania was celebrated by the University of Pittsburgh on Friday, February 28, 1913. The addresses were given by Provost E. F. Smith, University of Pennsylvania, President E. E. Sparks, State College, and President W. H. Crawford, Allegheny College. The honorary degree of doctor of science was conferred upon John Price Jackson, dean of the School of Engineering, State College.

DEAN F. F. WESBROOK, of the medical school of the University of Minnesota, has resigned to accept the presidency of the University of British Columbia. Dr. Wesbrook, who is a Canadian, has been largely responsible for the development of the medical school of the University of Minnesota and its recent reorganization.

PROFESSOR FREDERICK H. SYKES, director of the School of Practical Arts in Teachers College, has resigned in order to accept the presidency of the new Connecticut College for Women at New London.

DR. FREDERICK E. BOLTON has been elected dean of the new college of education at the University of Washington. Professor Bolton was called to the University of Washington last year from the University of Iowa, where he was director of the school of education.

THE fact that Professor E. B. Greene resigned his position as dean of the College of Literature and Arts of the University of Illinois when he took leave of absence last year, has been made public. The reason Professor Greene gives for resigning is that he did not desire the administrative work in connection with the office. At the time of the resigna-

tion, Dr. Arthur Hill Daniels, professor of philosophy, was appointed acting dean. Dean Daniels' appointment is to remain effective until something definite shall be done in regard to the proposed combination of the College of Literature and Arts, and the College of Science.

MR. C. SHEARER, M.A., Clare College, Cambridge, has been appointed university lecturer in zoology.

DR. CONSTANTIN CARATHÉODORY, of the Technical Institute at Breslau, has been appointed professor of mathematics at Göttingen as successor to Professor Felix Klein.

DISCUSSION AND CORRESPONDENCE

RELATIVITY IN ELECTROMAGNETIC INDUCTION

IN SCIENCE of January 17, 1918, S. J. Barnett adduces a certain experiment as constituting an *experimentum crucis* showing that complete relativity does not exist in electromagnetic induction. The experiment is certainly an interesting one, but on closer examination does not seem to be so definitely in contradiction to the principle of relativity as may appear at first sight.

For discussion let us consider the following simple form of experiment which illustrates the same principles. Take a cylindrical magnet magnetized longitudinally and symmetrically about its axis, and mount it in the axis of a somewhat larger cylindrical metal tube, with air or other dielectric between insulating one from the other, and forming a cylindrical condenser. Connect the two by a metal brush or cross-connection reaching radially across from the tube to the middle of the magnet. Now if the whole system considered as rigidly connected is spun around its axis of figure there will of course be induction and a difference of potential established between the magnet and the outer tube, and if the brush connection be broken while the system is in rotation, on bringing the whole to rest the condenser, consisting of tube and magnet, will be found charged.

So also when the tube alone is rotated while the magnet is kept at rest, a difference of potential is established, provided the metal connecting brush rotates with the tube. Or if the magnet is rotated and the tube kept at rest experiment shows the inductive effect to be the same if only the cross-connection rotates with it. And finally if both magnet and tube are kept at rest while the cross-connection alone is rotated about the axis of the system the observed effect is the same.

On the other hand, no inductive action is observed when tube or magnet or both together are rotated so long as the connecting brush is at rest.

The motion of the cross-connection is thus the determining factor, but relative to *what?* Must not any effect *that we can observe* be due to motion *relative to the apparatus and connections by which the inductive action is tested.*

Of course the induction may be conceived as due to motion relative to coordinates fixed in the ether or in space, and the effect would then depend on the direction of the axis of the magnet relative to the earth's axis, and the rotational velocity of the earth, and on its translational velocity in space. But even in that case the inductive action which also takes place on the system by which the effect is tested, in consequence of its motion in space, may be expected to be such that no inductive action could be *observed* except in case of such relative motion as is specified above.

For so long as the cross-connection and the testing apparatus by which the effect is to be observed are at rest relative to each other no change in the magnetic flux through the circuit will be produced by any rotation of the whole system about the axis of the magnet.

It appears therefore that if the testing apparatus rotates about the axis of the magnetic field at the same rate as the cross-connection between magnet and tube, no charge will be found, while if it rotates with an equal angular velocity in the opposite direction the charge found will be twice as great as if it were at rest.

If these statements are in accordance with the experimental facts, as I believe them to be, then such an experiment can afford no infor-

mation touching the motion of the ether in the field around a rotating magnet.

ARTHUR L. KIMBALL

AMHERST COLLEGE,
January 20, 1913

SCIENTIFIC METHOD

TO THE EDITOR OF SCIENCE: Permit me to protest vigorously against the exceedingly narrow conception of scientific method implied in Professor MacDougall's discussion of "neo-vitalism" in your issue of January 17. I am not a defender of neo-vitalism, and have no interest in the controversy between the neo-vitalists and their opponents; but I am interested in keeping the scientific method broad enough to apply to all phases of human experience. It is surely to be deplored that in this age, just when science is expanding to include all human life within its scope, a few scientific men should persist in interpreting scientific method in such a way as to limit its application to purely physical phenomena. If it is true that "natural science rests finally upon the assumption of mechanism [*i. e.*, rigid determination of all processes through the operation of mechanical causes] and excludes all other conceptions," then there can be no scientific treatment of religion, morality or any other phase of the mental and social life of man. Upon this assumption there can only be physical and biological sciences, and we must give up the hope of having mental and social sciences; for the impossibility of demonstrating mechanical causation in the mental and social realms is acknowledged by all careful thinkers and investigators.

Furthermore, the necessity of science assuming the universality of, and the rigid determination by, mechanical causation, is not evident, unless science wishes to transform itself into a system of monistic philosophy. Rather the pragmatic development of science would permit the assumption of one principle of explanation in one realm of phenomena where it works, and of another in another realm, where that works; for science is "a prolongation of common sense." Thus in the physical sciences no other principle than the mechanistic one is invoked, because mechanical cause and effect will work as a principle of explanation. But in a science like economics, for example, there is little use made of mechanical cause and effect as a principle of explanation because it will *not* work. All modern economics, as is well known, is built upon the conception of "value." Now, is economics a science, or not a science? To me the attempt to explain economic phenomena through mechanics is as absurd as the attempt to explain biologic phenomena through "entelechy." In either case it is the attempt to explain the known through the less known. The case is exactly similar with all the other social sciences. It may be replied that economics and the other social sciences are "sciences," but not "natural sciences." This reply, however, does not meet the issue, because no one can separate the natural sciences from other positive sciences unless the word "natural" be defined to mean the physical.

I am uncertain as to the purpose of Dr. MacDougall's argument, as to whether he wishes to limit greatly the scope of science (as do some philosophers), or to carry through the mechanistic conception as a universal principle of explanation (as do some scientists). In either case the argument practically denies the possibility of positive sciences of our mental and social life. To many people this is, of course, a welcome conclusion. But the whole development of modern science is against this conclusion. The extension of scientific methods to the mental and social realms of phenomena in the nineteenth century, without any use of mechanistic assumptions, was accompanied by as substantial triumphs in those realms as science has had anywhere. Is it not time to acknowledge this? It will not do to say that the assumption in all cases where science has made substantial advances in explaining mental and social phenomena has been that of mechanism; on the contrary, the mechanistic assumption, when brought in at all, has been brought in as a metaphysical "guess" which really explained

nothing. The use of such an assumption in most cases in the social sciences has usually turned out to be an attempt to explain the known in terms of the less known.

In conclusion, it seems to me that science *as science* may well beware of accepting as yet any universal principle of explanation. It can not accept such until it is demonstrated. The method of science is not, as some philosophers have proclaimed, to build itself up upon some universal assumption. Rather its methods are the pragmatic ones of observation, comparison, testing by experience and measurement. So far as science approaches exactness it is built up by the method of measurement; and many other things than mechanical cause and effect can be measured. It is decidedly premature as yet to say that science will approve any universal principle or method of explanation; and it is decidedly regrettable that any one who works in any of the sciences should, by a narrow definition of scientific method, rule out of the category of scientific works James's "Principles of Psychology" and the whole list of important contributions in the mental and social sciences not based upon the mechanistic assumption.

CHARLES A. ELLWOOD

UNIVERSITY OF MISSOURI,
January 20, 1913

"MORE LITTLE BEASTS"

TO THE EDITOR OF SCIENCE: Under the title of "More Little Beasts of Field and Wood," Mr. William Everett Cram, of Hampton Falls, New Hampshire, has given an account of various animals met by him in his walks through the woods, written in a pleasant fashion suggestive of Thoreau, though without Thoreau's touch of moral epigrams.

It is illustrated by a number of fairly correct wood-cuts.

A novel suggestion, at first sight not at all convincing, is this, that the group of hares and rabbits is not an off-shoot from the rodents, but from the family of cats, a rabbit in the long past being a cat, adapted perforce to a vegetable diet. A good many parallelisms between the cats and the rabbits are suggested, among others that cat flesh is sometimes substituted for that of rabbits in the inns of Europe.

DAVID STARR JORDAN

SCIENTIFIC BOOKS

The Horse and its Relatives. By R. LYDEKKER, F.R.S. New York and London, The Macmillan Company. Pp. vi + 286; Pls. XXIV., and 11 text figs. 1912. Price $2.60 net.

This extremely interesting volume is a companion to that on the ox and its kindred by the same author, and summarizes most admirably our knowledge of the members of the equine race, both living and extinct. In the opening chapter the place of the horse in nature is discussed, together with that of its few surviving relatives. The eight or nine species of horses, five of rhinoceroses and five or six of tapirs contrast strikingly with the great number of artiodactyles still living. The perissodactyles are therefore looked upon as a waning race, but the cause of their diminution in numbers is not yet determined.

In discussing the structure of the horse, especial emphasis is placed upon the high degree of specialization of feet and teeth. In the foot the variable degree of reduction of the splint bones is of interest, the great shire horse of England retaining the entire shaft together with remnants of the first and second phalanges of the lateral toes, all firmly welded together, while the Argentine horses show the greatest diminution of these bones. The longheadedness so characteristic of all horselike forms is a very ancient character and gives space before the eyes for the development of the wonderful dental battery. The pit-like depression in front of the orbit sometimes seen in modern horses is supposed to have lodged a scent gland, of recognition value, similar to that of the deer. The leg callosities known as "chestnuts" are also decadent skin glands. The long columnar teeth with their complex infolding of enamel are admirably adapted to the harsh siliceous grasses which constitute the principal article of diet. They are much more perfect than in the cud-chewing ruminants, in which the food

is subjected to a second chewing at the creatures' leisure, after having been softened in the stomach. In the horse the mastication must be hurriedly and efficiently done once for all.

The coloration of living horses gives rise to the belief that the Arab stock has been derived from a dappled bay, while in the domestic horses of western Europe, probably sprung from a different ancestral species, the primitive hue is dun, the color of withered grass. The tendency toward either melanism (black), erythrism (redness) or albinism (white) gives rise to the various color modifications. Striping is characteristic of all African wild horses, while those of Asia are more uniform.

The occasional presence of rudimentary paired horn-like processes upon the frontal bone, while never showing a corneous covering, is of interest. They are not vestigial, as no equine ancestors show them, and while Lydekker does not suggest it, may they not be indications of approaching racial old age?

Cope's idea that the horse tribe had two independent centers of development from animals of more primitive type, one in the old world and a second in North America, is rejected for that of Matthew, who assumes that "since the horses are represented by a double evolutionary series, one in Europe, a closer one in North America, their center of dispersal lay far enough north to spread into Europe on one hand, North America on the other, but that the latter was nearer or more accessible; *i. e.*, their center of dispersal was northeastern Asia or Alaska."

The wild tarpan or Przevalski's horse, still living on the steppes of Tartary and Mongolia, is the only true horse other than the domestic breeds which has survived. Historical evidences for wild horses in Europe may refer to feral animals, the ancestors of which had escaped from bondage. Prehistoric records, on the other hand, such as the drawings on the walls of caves, show the existence of a small, big-headed horse strongly suggestive of the tarpan. This is the so-called steppe type of Ewart. Two others are also represented by bones and teeth in the Pleistocene of England and the continent, one the plateau type of Ewart, a fine-headed, slender-limbed pony, also depicted in paleolithic art; and the forest type, a long, low horse with short, thick cannon bones and broad hoofs. All three of these are probably races of the modern *Equus caballus* and not separate species.

The author next discusses the domestic horses of the British Isles and some foreign breeds, and their probable origin, including the American feral horses. The latter are derived from those introduced by the Spanish conquerors and are of Barb stock.

Among other living equines the Kiang and Onager group come nearest the true horses. They are Asiatic in distribution, while the asses are apparently from the north of Africa. "It has been stated that 'the ass, and with it its name, accompanied the progress of the culture of the vine and olive to the north, not crossing the limits of that culture. In proportion as the ure-ox, the bison, and the elk died out, the long-eared foreign beast became domesticated in Gaul, receiving various names, and living in the customs, jokes, proverbs, and fables of the people. Germany, however, proved too cold for the animal.'" Asses have become feral in South America. Nearly related to the ass is the true zebra of southern and southwestern Africa, which, together with the now extinct quagga and the bontequagga or Burchell's zebra constitutes the distinctively striped horses of the Ethiopian realm. The curious association of zebras, gnus and perhaps a troop of ostriches to fill up the company, is mentioned, the ostriches apprehending danger through the sense of sight, the others through that of smell. The coloring of zebras, the protective value of which has been so vigorously denied by Colonel Roosevelt, is summarized by the statement that "whatever may be the real truth with regard to some of the disputed points, it is certain that when a zebra enters covert, it becomes, owing to its coloring, indistinguishable."

The final chapter summarizes our knowledge of the extinct forerunners of the horse, the records of which have been so well preserved.

Through each of the five stages—Pleistocene, Pliocene, Miocene, Oligocene and Eocene—of the uppermost eras of geological history we can trace a more or less complete gradation from the horses of the present day to primitive, many-toed animals, scarcely larger than foxes, and presenting few of the features which render the horse and its relatives such a remarkable group. Some idea of the immense lapse of time which has taken place during the slow evolution of the Eocene *Hyracotherium* into the modern *Equus* has been thus expressed by Professor H. F. Osborn, whom Lydekker quotes:

> The Rocky Mountains, it is true, began their elevation during the close of the Age of Reptiles; they had only attained a height of four or five thousand feet when the Age of Mammals commenced; they continued to rise during the entire period. But consider the map of Europe and Asia at the beginning of Eocene time and realize that the great mountain systems of the Pyrenees, the Alps, and the Himalayas were still unborn, level surfaces in fact, partly washed by the sea. . . . The birth of the Pyrenees was at the beginning of the Oligocene. At this time Switzerland was still a comparatively level plain, and not until the close of the Oligocene did the mighty system of the Swiss Alps begin to rise. Central Asia was even yet a plain and upland, and only during the Miocene did the Himalayas, the noblest existing mountain chain, begin to rise to their present fellowship with the sky. In North America, again, since the close of the Eocene the region of the present Grand Cañon of the Colorado has been elevated 11,000 feet and the river has carved its mighty cañon through the rock to its present maximum depth of 6,500 feet.

Those who have been impressed with a sense of the antiquity of these wonders of the world, and will imagine the vast changes in the history of continental geography and continental life which were involved, will be ready to concede that the Age of Mammals alone represents an almost inconceivable period of time.

Richard Swann Lull

Yale University

Electricity and Magnetism for Advanced Students. By Sydney G. Starling. Longmans, Green & Co. 1912. 583 pages, with 452 figures.

This book is the outcome of a number of years' experience in teaching the subject to senior students in an English municipal technical school, and it is a good book. To quote from the preface, it aims "to give such students an adequate knowledge of the present state of the subject, with due reference to the historical sequence of its development, and to the effect of modern research upon it." Its seventeen chapters are devoted to magnetism, terrestrial magnetism, the electric current (2), electrostatics (2), electrolysis, thermoelectricity, electromagnetics, magnetic properties of materials, varying currents, alternating currents, units, electromagnetic radiation, conduction in gases, radioactivity, and electrons. Instruments and methods of measurement receive a great deal of consideration. Each chapter is provided with a number of examples, mostly taken from London B.Sc. and B. of E. papers.

The book follows for the most part conventional lines. Its descriptive matter is clear and full and usually correct. Its mathematical demonstrations are ordinarily sufficiently direct and simple, though it seems to the reviewer that some of them might have been dispensed with and that others, *e. g.*, those pertaining to the Wheatstone and Thomson bridges, would profit by simplification. The calculus is freely used throughout.

As to matters of fact the book is fairly up to date. In many cases, however, important recent contributions receive no mention—such as the use of the methods of electromagnetic induction in terrestrial magnetism, the precise work of Rosa and Dorsey on the ratio of the unit charges, and the brilliant work of Langevin, Weiss and others in the domain of magnetism.

In matters pertaining to fundamental theory the treatment is not always logical and free from looseness. Thus the definitions of electromotive force and potential difference are unsatisfactory; resistivity is defined without reference to the direction of the streamlines; the curl of a vector is defined as its line integral around a closed path; and Gauss's theorem, demonstrated for a homogeneous field only, is assumed without comment to

hold for all fields—an error common to nearly all books on this subject. And many other errors have been noted, most of them pertaining to the theory of instruments.

As in many other books, great use is made of the magnetic shell. In the reviewer's opinion magnets of all types, real or fictitious, but especially the magnetic shell, should be completely abolished from the fundamental parts of electrical theory—as indeed they have already been abolished by some writers. The reviewer must protest also against the author's use of the word *field*, which properly denotes a *region*, to designate field *strength* or field *intensity;* and the use of the word *force* in place of the word *stress* when two forces—both action and reaction—are contemplated. These usages are all too common, and the book under review is no more guilty than many others.

In spite of such defects as have been mentioned it may be stated again that this is a good book. And it should be useful to many students.

S. J. BARNETT

THE OHIO STATE UNIVERSITY

The Science of Human Behavior: Biological and Psychological Foundations. By MAURICE PARMELEE, Ph.D. New York, The Macmillan Company. 1913. Pp. xviii + 443. $2.00 net.

It is the subtitle rather than the main title that indicates the scope of this work, which might perhaps have been better named prolegomena to a science of human behavior. No attempt is made to gather together the rather extensive studies of human behavior already produced by experimental psychology, and indeed the existence of this work is not even recognized, nor are its methods set forth. The author's view is that human behavior must be approached from the biological and physiological side. "Psychical and social phenomena should be reduced as far as possible to biological terms, just as vital phenomena should be reduced as far as possible to chemical and physical terms" (Preface). "To begin the study of behavior from a biological point of view has, I believe, a very wholesome effect, for it necessitates the use of more or less exact methods of observation which are not always used in psychology and sociology. The use of these methods results in the disappearance of hazy and mystical explanations of human phenomena frequently proposed by writers in these two sciences. These explanations are replaced by more or less exact mechanical explanations" (pp. 2–3). The nature of these mechanical explanations is indicated by the author's method, which seeks to obtain clear concepts of the simpler types of behavior, and then to show how these simpler acts are combined into more complex behavior of a mental and social sort. The method is, therefore, comparative and genetic; and phylogenetic rather than ontogenetic. Tropisms and other reactions of the simplest organisms, reflexes of animals possessing a nervous system, instincts, which are defined as combinations of reflexes integrated by the nervous centers, learning, intelligence, consciousness, society, are successively treated; and some attempt is made to trace the evolutionary process through these increasingly complex modes of behavior. As might be expected, this attempt to trace the phylogenesis of human behavior is not specially successful, on account of the impossibility of selecting a series of animal forms representing the direct line of human descent; and the study is thus, after all, comparative rather than genetic. For example, considerable attention is devoted to the social behavior of insects and of birds, which certainly has no direct bearing on the evolution of human behavior. For the specific purpose of the book, much of this incidental material might well be replaced by something on the growth of behavior in the human individual.

The book is of the Spencerian type, beginning with the characteristics of matter in general, and ending with social evolution. It has required the bringing together of material from various sciences: physics and chemistry, zoology, physiology, psychology, anthropology. One would expect it, accordingly, to be broad rather than notoriously exact; and it is likely to produce the same sort of impression

that is produced by Spencer's work, least satisfactory where the reader knows most about the subjects treated. Certainly under the heads of neurology and psychology, it is somewhat inaccurate and a trifle naïve. The author seems willing almost anywhere to take up a position on questions that are controverted and inherently difficult of decision. Another criticism is that the deductive tendency is more implicitly followed by the author than the nature of his material allows. Once having reached a (perhaps tentative) conclusion on some question, he is satisfied to use this conclusion as the basis of far-reaching deductions. For example, this is his evidence in favor of a richer emotional life in warm-blooded than in cold-blooded animals: "The warm-blooded type developed as a result of the development of the sympathetic nervous system, which regulates the vasomotor system in such a fashion as to keep the body at a uniform temperature by sending blood where more warmth is needed and stimulating the action of the sweat glands where the heat needs to be reduced. I have not the space to discuss the causes for this development here. As we have seen in an earlier chapter, the emotions arise out of the activity of the sympathetic system, so that the development of that system means the development of the emotional nature of these classes of animals. So that the emotions involved in sexual, parental and wider social relationships now begin to play a wider part" (pp. 372–373). It is but fair to say that the author's treatment is much more satisfactory when the broad trend of the book is considered than when particular passages are taken for examination. Certainly it is well to bring emphatically before the reading public the notion that a science of human behavior is possible (and actual, as well, to a much greater degree than this book indicates), and that this science is distinctly a biological science, related to the study of animal behavior, on one side, and on another, to the structure and functions of the nervous system.

R. S. WOODWORTH

COLUMBIA UNIVERSITY

BOTANICAL NOTES

FIGHTING THE CHESTNUT BLIGHT

ONE of the most interesting contests is now being waged between the trained plant pathologists on the one hand and a parasitic fungus on the other, and thus far it must be admitted that the outcome of the battle is by no means as assured as we could wish it to be. The chestnut tree is found naturally in an area stretching from southern Maine to Georgia and Alabama and extending a greater or less distance east and west of the Appalachian Mountains. A few years ago (1904) a disease of the bark of this tree appeared near New York City, and from this point it has spread northeastward, westward and southeastward as far as Massachusetts, Vermont, Central Pennsylvania, Maryland and Virginia. It has been made out that the disease is due to a Sphaeriaceus fungus known as *Diaporthe parasitica,* the structure of which has been pretty well investigated.

So threatening has this disease become that last February a general conference was held in Harrisburg, Pennsylvania, for the consideration of ways and means for preventing its further spread, the results of which appeared a little later in a thick pamphlet of a little more than two hundred and fifty pages of papers, discussions and proposed programs. Many half-tone reproductions of drawings and photographs add greatly to the value of the publication, which must prove to be most useful to the man who wants to try to save his chestnut trees, as well as to the botanist who wishes to keep in touch with this contest between pathological science and a rapidly spreading, disease-producing fungus. As the pamphlet is a state publication it can no doubt be had by application to the governor, at Harrisburg, Pennsylvania.

BOTANICAL NOTES

A HANDY little flora of central and northern Europe has been compiled by F. Hermann, and published by Weigel (Leipzig) under the title of "Flora von Deutschland und Fennoskandinavien sowie von Island und Spitz-

bergen." It covers the area bounded westwardly by Belgium and eastern France, southerly and easterly by Switzerland, Galacia and central Russia, to the White Sea, Spitzbergen and Iceland. It thus includes Germany, Belgium, Holland, Denmark, Norway, Sweden, more than one half of Russia, besides parts of Austria and France, and the islands mentioned. Yet in spite of the large area included the book contains only 524 small octavo pages. It should serve as a good model for our North American manuals.

Miss Frederica Detmers has published her dissertation for the doctorate, "An Ecological Study of Buckeye Lake," as a contribution to the phytogeography of Ohio, constituting a pamphlet of 138 pages. This artificial lake, a little more than seven miles long, and from a quarter of a mile to a mile and a half in width, was constructed eighty years or more ago on the site of an impassable swamp. Some interesting studies were made by Miss Detmers, and these are recorded in her paper. There is an annotated list of plants collected in and about the lake, and a good bibliography.

The New Jersey Forest Park Reservation Commission has issued a useful pamphlet entitled "The Planting and Care of Shade Trees" which may interest botanists, and certainly will do so for those who are interested in trees. The second half of the book is devoted to "Insects Injurious to Shade Trees," by the state entomologist, J. B. Smith, and "Diseases of Shade and Forest Trees," by the state plant pathologist, M. T. Cook. Many good "half-tone" reproductions of photographs add much to the value of the report.

Allied to the foregoing is the paper on "Cultivation of Native Ornamental Plants," by Miss Eloise Butler, in the October *Minnesota Horticulturist*. In it the author enthusiastically urges the use of a large number of wild plants, listing them under the following heads, Trees, Shrubs, Woody Vines, Herbaceous Vines, Shade Plants, Early Flowering Herbs (chiefly shade plants), Flowering Herbs that will grow in Full Sun. On reading the paper one is filled with a desire to make a little wild garden in one's back yard.

Here we may notice briefly Professor Henry Kraemer's "Outlines of Courses in Botany, Microscopy and Pharmacognosy" for pharmacy students. The "first year's work" (botany) as here outlined is one of the best we have seen.

A dozen years ago Professor Selby, of the Ohio Agricultural Experiment Station, published a bulletin (No. 121) entitled "A Condensed Handbook of Diseases of Cultivated Plants in Ohio," which proved to be so useful that a demand sprang up for it all over the country. Two years ago he published in pamphlet form a revised and enlarged edition (No. 214) under practically the same title, and now we have a bound book with essentially the same matter as the second edition but with the title "Handbook of Diseases of Cultivated Plants." This also is issued by the Experiment Station, and is numbered as before (214). In its present form it is a handy book of somewhat more than one hundred and fifty pages of text and includes one hundred and six text illustrations. We may hope that in time this may grow into a still more complete handbook of plant diseases, the need of which is suggested by the demand shown for this bulletin.

Charles E. Bessey
The University of Nebraska

THE AGE OF PICANTHROPUS ERECTUS

Just twenty years ago Dubois startled the scientific world by his announcement of the discovery of the skeletal remains of an ape-man, *Pithecanthropus erectus*, near the hamlet of Trinil in east central Java. The age was supposed to be Pliocene, and recently Dubois has reiterated his belief in the Pliocene age of this unique material, in which he is confirmed by Stremme and others. Discussion of the age of these remains has been the basis for a considerable volume of literature and the recent tendency has been toward considering *Pithecanthropus* younger rather than older. Thus Martin and Elbert assign it to the old

Pleistocene while Volz, Carthaus, etc., consider it middle Pleistocene. The two Selenka expeditions to Java in 1906–07 and 1908 made rather extensive excavations at Trinil and brought back large collections of fossil plants. These have now been described by Schuster,[1] of Munich, and as the results are important the readers of SCIENCE should have their attention called to Schuster's conclusions.

The exposure of the *Pithecanthropus*-schichten at Trinil at the locality where the human remains were found in 1893 is about 25 meters in thickness and consists of interbedded conglomeratic tuffs, lapilli, ash-beds and clays, partially fluvial or lacustrine and probably partly eolian. Plant remains either as leaf-impressions, lignite or petrified wood are scattered throughout the section, occurring most abundantly, however, in stratum No. 6 in the lower half of the section and at the level at which *Pithecanthropus erectus* was found. Eight species of fresh-water gastropods were collected from member No. 4 above the main plant bed, and waterworn bones occur in member No. 5 which is above, and No. 9 which is below, the main plant bed. The main bone stratum, No. 9, contains a meager fauna which is said to show affinities with the Pliocene Siwalik fauna of northern India.

The flora described by Schuster comprises fifty-four species, none of which are extinct, distributed among twenty-two families. The most abundant families are the Moraceæ and Anonaceæ each with eight species, and the Lauraceæ with six species. The geographical distribution of these fifty-four species in the existing flora is somewhat different from what it was at the time of *Pithecanthropus*. Only ten still flourish in the immediate vicinity of Trinil although thirty-two or 62 per cent. are still found on the Island of Java. Twenty-nine or 57 per cent. are mainly Indo-Chinese in the modern flora and one species, *Uvaria zeylanica* of the Anonaceæ, is confined to Malabar, Ceylon and India. Schuster concludes that this flora is of Pleistocene and not Pliocene age, and there can be no question of the correctness of this conclusion, since all the forms are still existing, while in the upper Pliocene flora of Mogi described by Nathorst from this same general region 40 per cent. of the species are extinct. Moreover none of the Pliocene plants described by Crié from Java are present in the present collection. Schuster considers that this Pleistocene flora indicates an annual rainfall of about 400 cm. and a mean temperature of 64 to 68 degrees Fahrenheit. If these deductions are legitimate they show that temperatures were somewhat lower than present-day Javan temperatures, while the rainfall was somewhat greater than it is at the present time. Schuster considers that this Pleistocene flora flourished during a pluvial period which corresponds to the Mindel or second glacial period of Alpine glaciation according to Penck's nomenclature, and that *Pithecanthropus erectus* is slightly older than *Homo heidelbergensis* discovered in 1907 by Schoetensack at Mauer near Heidelberg, Germany. Just how this exact correlation is reached it is difficult to understand; in fact I hardly see how there can be any reliable data for such a long range correlation. It seems to me that the exact stage in the Pleistocene is undeterminable. According to Schuster's correlation the age is lower middle Pleistocene, although he calls it old Pleistocene. In the temperate zone a fossil flora with no extinct species indicates a late middle or upper Pleistocene age, but very likely this does not apply with equal force to tropical regions where the physical conditions have been more uniform than in the temperate zone.

The three largest of the Sunda Islands—Java, Borneo and Sumatra—are separated from the Indo-Chinese mainland and from each other by shallow seas less than one hundred fathoms in depth and for the most part not deeper than fifty fathoms. These seas date from the submergence in the late Pleistocene. In spite of this fact and the further fact that the mountain axis of Sumatra also

[1] Schuster, "Monographie der fossilen Flora der Pithecanthropus-Schichten," *Abh. k. Bayer. Akad. Wiss., math.-physik. Klasse*, 25 Band, 6 Abhandl., 1911.

forms the backbone of Java, the intervening Sunda Strait being only fifteen miles across, the existing flora and fauna of Java are less like those of Sumatra than those of the latter are like those of Borneo. The biota of Java is, on the other hand, much more like that of the Siamese peninsula and northern India, and it is very interesting to find similar and apparently anomalous affinities shown as long ago as the Pleistocene and certainly before the submergence which gave the region its present physical geography.

Edward W. Berry
Johns Hopkins University

SPECIAL ARTICLES

SOME RELATIONS BETWEEN ROOT CHARACTERS, GROUND WATER AND SPECIES DISTRIBUTION

Observations on the root habits of desert shrubs indicate that the root-type of any species may be of importance in limiting the distribution of the species. This has been found to be especially clear in the case of plants having obligate tap roots, which, as a rule, are confined to relatively deep soils. Such shrubs as have a generalized root-system, on the other hand, have a wide local distribution, which may be correlated with the fact that the roots of these plants are capable of a large degree of modification in conformity with the pressure of the soil environment. But the rôle of the superficial type of roots, such as is typical of species with water storage capacity, is not so well defined. It is known that the fleshy cacti, for example, are most highly developed where the rainfall is a periodic one, occurring, perhaps, twice each year, but that these plants occur sparsely where the precipitation takes place once annually. Whatever may be the reason for this limitation, it is noteworthy that the larger mass of absorbing roots of species having a water balance lie within 10 cm. of the surface of the ground. The superficial soil layer is subject to the most intense desiccation, and, hence, carries moisture in sufficient amount for the use of plants for the shortest period only, so that plants depending on this stratum for moisture must either be short-lived or have the capacity of storing up water against the following period of drought. What the minimum absorption time of fleshy plants is, has probably not been determined, but it is evident, from their distribution, that the amount of available moisture in the superficial soils derived from a single rainy season each year is not sufficient. To put the case in another way, it is apparent that the general and local distribution of the fleshy cacti would be other than it now is, if such plants had another type of root-system, for instance, if there was an obligate deeply penetrating root-system, in place of the superficial one they now have. Such a change, were it possible, would, in the first place, limit the local distribution to flood plains or to other areas having deep soil, and, in the second place, it would permit a wider general distribution. This suggestion makes it evident that the root-soil moisture relation may be an important factor among those which determine the survival of a species.

Such observations as have been made on the root habits of trees indicate that in these large-bodied plants the root character may also be of importance among the factors which operate to influence their distribution.

It is now well established, at least for a portion of the Southwest, that there may be a very intimate relation between the occurrence of certain species of trees and the character of their roots, having regard to the depth at which perennial water may be found. Here trees occur along streamways, while the near-by upland may be treeless. The humidity of the two areas may not be very unlike, nor the rainfall, nor yet the temperature. The great difference, which is often striking, lies mainly in the soil conditions, particularly with regard to the depth to the ground water. On the bottoms the water table lies within reach of the roots of trees, while on the more elevated land it is far below them.

The depth to the level of ground water, or to the soil that is moistened from the water table, is usually not great. In the eastern portion of the United States, in lands of mod-

erate elevation, water can commonly be obtained within 30–40 feet of the surface, while in the valleys the water lies at a depth of 15 feet, or less.[1] In the states of the middle west, as in Kansas and Nebraska, according to various sources, mainly the Geological Survey, the depth to ground water on the flood plains of streams varies from 10 to 40 feet, but the depth on the benches, valley sides and upland is from 60 to several hundred feet. A like condition is to be found in the more arid regions further west, while the more humid regions of the extreme West are similar, as regards depth to the water table, to the humid east. In rough and mountainous regions, the water reservoirs of whatever kind may be regarded as the physical equivalents of the water table of the more level country, and provide such plants, especially the trees, as penetrate to them, or to the soil moistened by them, with a perennial supply of water.

The various physical factors, climatic as well as those pertaining to the soil, which influence the distance to ground water, are, in the main, of significance in the physiological activities of the trees occupying an area. And, in addition to such factors, appropriate temperatures being assumed, the specific responses of trees to the water relation are to be considered. Chief among these are the water-retaining and water-absorbing capacities and adjustments, of which the root-ground water relation must be considered to be of great importance.

The general relations of trees to perennially moist soil, as indicated by the depth of the water table and by the distribution of trees and forests, and taken from a few widely separated regions, may be illustrated by a few examples.

In southern Arizona, in the vicinity of the Desert Laboratory, the distance to the water table, or to perennial ground water, is various. On the bajada, water is to be obtained at a depth of 70 feet, or over, while on the flood plains of the streams it lies from 15 to 35 feet beneath the surface. There is practically no arboreal flora on the bajada, but along the streams, and on their flood plains, occur ash, cottonwood and mesquite, the latter often forming an open forest of trees ranging as high as 40 feet, or more. The mesquite may be taken to illustrate the relation between trees of the vicinity and the depth to perennial water supply.

The mesquite is the most widely distributed tree of the Tucson region, occurring not only on the flood plains of streams, but on the higher bajada as well. The form of the species, however, when growing in such diverse habitats is quite unlike, since apart from the flood plains it assumes the form, not of a tree, but of a shrub. There is a close association between the dual habit of the mesquite as noted and the depth to the water table, which is also shown by a variation in the development of its roots.

The root-system of the mesquite is an extremely variable one. It may penetrate the ground deeply, or it may extend widely and lie not far beneath the surface of the ground, or, again, it may be of rather limited extent and of a generalized character. The first type of root is probably most characteristic of the tree form, and the last of the shrub form of the species, while the second arrangement may be connected either with the tree or the shrub habit. On the flood plain, roots of the mesquite as a tree have been seen to penetrate to a depth of 15–24 feet, or to the level of the water table. Under especially favorable soil conditions, as where it is fairly homogeneous and easily penetrable, the roots may attain a greater depth.

A comparison of the distribution of the tree form of the mesquite with maps which give the water table depths indicate that the species becomes a tree, soil conditions favoring, where the ground water does not lie deeper than 50 feet. On the other hand, where the water table is at a greater distance, or is otherwise not available, the shrub habit is assumed, with characteristic generalized root-system.

[1] Crider and Johnson, "Water Resources of Mississippi," U. S. Geological Survey, Water-Supply and Irrigation Paper No. 159, 1906.

An extension of observations on tree distribution, as related to the depth of perennial water, to regions outside of southern Arizona, gives interesting, if not entirely conclusive, results. A comparison of the depth to ground water of the Coastal Plain of Texas, as given by Taylor,[2] with the tree distribution, as given by Bray,[3] for example, offers important suggestions in the present connection. In general, it may be said, that the stream bottoms of the Coastal Plain support a hardwood forest, which also extends over such upland as has a fairly shallowly placed water table. Such of the deciduous trees as are marked xerophytes, for example, the post oak, occur on dry ridges where pines of various sorts are also to be found, and where the depth to permanent water is considerable. Of these trees, the root habit of the long-leaf pine is known. This species has a long tap root which penetrates to a great depth and which renders the species in a measure independent of surface conditions of soil and moisture. In the more arid southern portions of the Coastal Plain, where the water table lies below 50 feet, chaparral is characteristic of the upland, and, along the streams, where the water table is less deep, forests occur.

Northward from Texas, as well as westward from the Coastal Plain of the state, are to be found conditions analogous to much already noted for southern Arizona and the Coastal Plain. That is, other things being equal, trees and forests, especially deciduous forests, are limited to areas where the depth to the water table is not great. Thus, in Kansas and Nebraska, the deciduous forests are mostly confined to the flood plains of streams, while the adjacent upland is treeless.

As one examines other regions (reference is made more in particular to those that are semi-arid) he finds forests confined to such areas as are underlain by ground water not beyond the attainment by the roots of trees.

[2] U. S. Geological Survey, Water-Supply and Irrigation Paper No. 190, 1907.

[3] U. S. Dept. Agric., Bureau of Forestry, Bull. No. 47, 1904.

Although it is not practicable at present to give in detail the relation of tree roots to the water table in the more humid regions, enough is known to justify the belief that often there is a very intimate relation between the two, according to Bowman.[4] For example, the level of the ground water is said always to be lower in a forested tract. The same writer states that the greater supply of moisture for trees is derived from deeper lying sources, *i. e.*, than which supplies shallowly rooted plants. The roots, also, which supply the moisture, descend to a point a little above the surface of the ground water. If the level of the water table changes greatly, the trees suffer either from lack of moisture, or from poor aeration, according as it is lowered or raised. The variation in depth to the ground water, however, does not affect trees having superficial roots, or at least roots which do not attain it, and such species are well adapted for growth where the water table is high, or the upper soil is shallow. The ecological importance of this is apparent, and may be illustrated by a single example. Rossmässler[5] mentions trees which are characteristic of two habitats, of which one is rough and stony, and the other is underlaid by an impervious clay. Oaks and pines form a mixed forest in the first habitat, and of these the oaks at least have deeply penetrating root-systems. In the second habitat there is only *Picea*, since the soil depth prevents such root development as is characteristic of the other species.

An important phase of the study of the relation of roots to the water table lies in observing the range of variation under natural conditions. Specialized roots, such, for example, as were mentioned at the beginning of this note, are, generally speaking, not capable of great variation. Hence, plants with this character of a root-system, and for this reason only, may have sharp bounds placed on their distribution. On the other hand, generalized root-systems are often variable to a high degree, and, corresponding to this fact,

[4] "Forest Physiography," p. 42, etc., 1911.

[5] "Der Walde," p. 31, 1881.

the species bearing generalized roots may have a relatively wide distribution, occurring in widely different habitats. Cowles[8] gives an interesting example of the relation between root variation and species range. The red maple grows in swamps and also on dry grounds. The root character of the tree on the two habitats is very unlike. In the swamps the tap root is not largely developed, but the laterals are prominent, while in the dry situation the reverse is the case, the tap root being the leading characteristic of the root-system.

The problems which deal with the presence of trees are primarily physiological and have mainly to do with the absorption and conservation of water. Each of these capacities varies with the species. Of the root relations that of the root-water table is of prime importance, owing to the fact that the soil horizon, tapped by the roots of trees, derives, by capillarity, from the level of ground water, its perennial supply of moisture. In the semi-arid regions probably the roots of most trees attain to the perennially moist soil, sometimes to the water table itself, at least for a portion of the year, and, in the more humid regions, the roots frequently do so. In both regions, certainly in the former, wherever such is not the case, a variety of factors, which need not be discussed in this place, are of greater importance in the survival of the species than the water table depth, although the character of the root-systems may still be of much, possibly of definitive, importance.

W. A. Cannon

Desert Laboratory

INORGANIC COLLOIDS AND PROTOPLASM[1]

Bredig[2] has shown that inorganic colloidal solutions, such as silver, platinum and gold, may act as catalyzers in certain chemical reactions, such as the reduction of hydrogen peroxide to water, and while chemists have studied the problem of the action of catalyzers from this standpoint, biologists have signally avoided attempts[3] to determine whether the activities of the enzymes of the organism can be imitated by these inorganic catalyzers. It must be remembered in any such examination that, as Ostwald[4] has demonstrated, along with others, enzymes of any nature are incapable of instigating a reaction, but their function is solely that of modifying the Guldberg-Waage mass action equation for a given instance, either accelerating or retarding a reaction already in progress. Therefore, we should not expect to find a striking modification of the actions or of the structure of any organism, if any effect were obtained by the application of inorganic "enzymes."

In a series of experiments, I attempted to determine whether colloidal platinum and a colloidal gutta percha[5] gave evidence of any effect upon simple organisms, such as protozoa and single-celled plants. Platinum black was obtained by the use of the house current, reduced to about 70 volts, passing it through a lamp-board, the current delivered to water which had been glass-distilled, the electrodes being of platinum, according to the Bredig method.[6] In order to be certain that the solution was desirable for experimentation, it was examined over a Zeiss dark-ground con-

[8] "Text-book of Botany," Vol. 2, Ecology, p. 506.

[1] Presented in abstract form to the Columbia University Biochemical Association and outlined in the *Biochemical Bulletin*, II., 1, 1912.

[2] "Anorganische Fermente," Leipzig, 1901.

[3] Benj. Moore (in "Recent Advances in Physiology and Biochemistry." L. Hill, Edt. London: Edward Arnold, 1908; Chapter 4, p. 122) mentioned having performed injection experiments with platinum sol on animals, but he gives no details; he obtained negative results. Autolysis has been shown to become accelerated under the influence of colloidal metals. (See Ascoli and Izar, *Biochem. Zeitschr.*, Bde. 5, 7, 10, 14 and 17; also Doerr, same journal, Bd. 7.)

[4] "Uber Katalyse," *Vortrag auf d. Ges. d. Naturf. u. Arzte*, 1901.

[5] Professor Henry A. Perkins, of the Jarvis Physical Laboratories, Trinity College, prepared this solution after the formula which he used in the laboratory of Professor Perrin at the Sorbonne, and I am indebted to him for the kindness.

[6] *Zeitschr. f. angew. Chemie*, 1898, p. 951.

denser, but no attempt at ultra-filtration, which might easily have been done by using collodion as Schoep[7] has done, was made, for I was not concerned in these experiments with the size of the particles. The solutions were found to be quite active and little or no deposit of the coagulated platinum ["sponge"] was obtained, which, of course, is not active catalytically to the extent to which platinum black is. I have tried colloidal iron in somewhat similar experiments, but it is assuredly not to be expected that this colloid would give results with living things, on account of its low activity as an inorganic catalyzer. The gutta percha was dissolved in ether and emulsified by water and alcohol, and then the whole mass was dialized through fish-bladder for three months to remove the alcohol and ether. It was examined before using, to determine the activity as far as the Brownian movement could be taken as a criterion.

Paramecium, Stentor, Blepharisma, Euglena, Phacus and diatoms, *Ceratium* and other desmids were used as material, but more exact work was done with *Paramecium* and *Stentor*. One set of experiments consisted in isolating individuals of these species and making drop-cultures of them in a small amount of the colloidal solution; a second series was conducted in salt dishes, where the amount of colloidal solution was about 2 cm^3. I ran checks with tap-water.

It was to be expected that the platinum solution, at any rate, would prove to be toxic, but this was not the case, for the organisms lived without any suggestion of being in an unwholesome medium; the same was true for the gutta-percha solution. The rate of cell-division was noted, comparing that of the individuals under experimentation with that of the checks. The rate was found to vary in no appreciable manner. One variable may have been introduced, and that was food, but I could not devise any way of eliminating the difficulty. Bacteria were present in all of the solutions and, of course, in the medium of the control experiments. The bacteria were kept down appreciably by keeping the dishes in strong light, but this did not eliminate them.

From these experiments, which are by no means exhaustive, I conclude that the inorganic catalyzers, such as I have used, are not effective in appreciable manner on protoplasm. It may well be that protozoa are not affected, while other organisms, or portions of other organisms, may be. As an instance where protozoa are not affected by an agent that is markedly effective in inducing cell-division in certain tissues in higher forms, I may mention the power of certain azo-compounds, notably Scharlach R, to cause proliferation of epithelium in mammals, so that they have been introduced into dermatology for treatment of burns on the skin, and it has been noticed that workers in anilin factories[8] show thickenings of the skin caused by contact with the dyes. I have grown *Paramecium* in drop-cultures with granules of Scharlach R, which were seen to enter the bodies of the organisms and to occur in the food vacuoles, but there was no evident increase either in the size of the organisms or in their rate of fission. Obviously, the dye is not responded to by protozoa as it is by epithelium; perhaps this specific response is somewhat similar to conditions in experiments with inorganic catalyzers. In these experiments, both a suspensoid [colloidal Pl and an emulsoid [gutta percha] were used. It is to be remembered that the study of inorganic catalyzers has been carried on principally with the latter group, but this does not mean that the former one is not promising, or for *a priori* reasons should not be expected to give results, except in so far as it does not follow the criterion of Emil Fischer[9] of a stereochemical relation, wherein enzymes of whatever nature are defined as optically active catalyzers; platinum black is not optically active, which may account for its inability to influence organisms. The same may be said of the gutta-percha solution.

P. S.—Since the above account of my experiments was written, there has appeared a very

[7] "Über ein neues Ultrafilter. Wo. Ostwald's Kolloid-Zeitschr.," Bd. 8, p. 80, 1911.

[8] See Sachs, *Wien. klin. Wochenschr.*, Bd. 24.

[9] *Chem. Ber.*, Bd. 27, S. 3230.

interesting communication from the Barnard Skin and Cancer Hospital in which Dr. Leo Loeb describes experiments with colloidal copper, derived by the Bredig method, upon neoplasmic growths; he finds that intravenous injections cause cessation and absorption of the cancerous tissue.

MAX MORSE

TRINITY COLLEGE,
October 25, 1912

SOCIETIES AND ACADEMIES

THE AMERICAN PHILOSOPHICAL SOCIETY

AT a meeting of the society on February 7 Dr. Paul Heyl presented a paper on "Platinum in North Carolina." A belt of platinum-bearing rock runs from Danville, Va., to Cedar Falls, N. C., a distance of some seventy miles. Assays of as much as 4 or even 8 ounces per ton are occasionally found, but the average content is too small to be commercially important. The platinum in the rock is very rich in iridium. The deposit has been known for about seventeen years. An examination of the watershed of the region for 200 miles from the center for placers yielded negative results.

On March 7 the following paper was presented: "A Historical Account of the Early Microscopical Studies in the Structure of Animals and Plants with Reference to the Development of the Cell Theory," illustrated by lantern slides, by R. M. Pearce, professor of research medicine, University of Pennsylvania.

A sketch of the work of Hooke, Malpighi, Grew, Swammerdam and Leeuwenhoek in the last third of the seventeenth century, with remarks on the early microscopes, followed by the story of the development of our knowledge of plant and animal structure, as Lieberkuhn's (1739–48) studies of the finer structure of animal tissue, Trembly's (1744–47) observations on the division of protozoa, Brown's (1833) description of the nucleus and Treviranus's (1806) and Mohl's (1828) studies of the vegetable cell. A discussion of the improvements in the microscope up to 1830 and of the fundamental observations of Schleiden (1838) and Schwann (1839) which, followed by those of Virchow (1858), definitely established the cell theory. A short discussion of later work on the nature of cell protoplasm (Dujardin, Schultze) and the study of the nucleus and the process of division of cells, concluding with Flemming's observations in 1882. Illustrated by lantern slides showing many of the original drawings which accompanied the reports of the various fundamental observations.

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 33d annual meeting was held in the hall of the Cosmos Club, December 14, 1912, with Vice-president W. P. Hay in the chair. Reports of officers for the year 1912 were received and the annual election of officers took place. The election resulted as follows:

President—E. W. Nelson.

Vice-presidents—J. N. Rose, Paul Bartsch, W. P. Hay, A. D. Hopkins.

Recording Secretary—D. E. Lantz.

Corresponding Secretary—N. Hollister.

Members of Council—Hugh M. Smith, Vernon Bailey, Wm. Palmer, A. B. Baker and A. K. Fisher.

THE 505th regular meeting was held January 11, 1913, with President E. W. Nelson in the chair and 54 persons present. The chairman appointed standing committees on publications and communications for the year.

C. V. Piper exhibited a vase made of wood and covered with a thin veneer of "silk-wood." This veneer is cut from one of the large *Polyporus* fungi and takes a beautiful polish.

A. S. Hitchcock and E. W. Nelson each reported his recent return from a successful collecting trip, the former having collected grasses in Jamaica, Trinidad and Tobago, while the latter had secured birds and mammals in Arizona.

The regular program consisted of three communications:

The Rediscovery of Œnothera grandiflora: S. M. TRACY.

The speaker gave an account of two trips made by him to the locality of Bartram's original discovery of this species (1776). The locality is near Dixie Landing, Alabama, and the flower described by Bartram was found abundant over a limited area. A second visit was made last year in company with Dr. Hugo de Vries.

The Problem of the Identity of Œnothera Lamarckiana: H. H. BARTLETT.

The speaker gave a history of various cultivated strains of plants of this species and its hybrids. He predicted that its original habitat and identity —as yet unknown—would eventually be discovered, probably in America south of the United States and on the Pacific Slope.

Sawflies and their Relations to Forestry: S. A. Rohwer.

These very destructive insects were classed as defoliators and wood borers, and many instances of serious damage by them to growing timber were given. The paper was illustrated by numerous lantern slides showing various species of sawflies —adults, pupæ and larvæ—and also illustrations of damaged timber.

The 506th regular meeting was held January 25, 1913, with the president in the chair and 47 persons present.

The following resolution relating to zoological nomenclature was presented to the society with the endorsement of the council and adopted unanimously:

Whereas certain zoologists have gone on record as favoring

1. A permanent and increasing list of exceptions to the law of priority,

2. A return to the principle of elimination regardless of the generic types that have been designated under the rules, and

3. A rejection of the present unanimous vote rule that has obtained for so many years in the International Congress on Zoological Nomenclature.

Therefore, be it resolved by the Biological Society of Washington that we favor

1. The consistent application of the law of priority in all cases,

2. The acceptance of the first designation of a genotype, regardless of the method followed in designating it, and

3. The present unanimous vote rule as making for conservation and stability in nomenclature.

Under the heading Brief Notes, etc., Paul Bartsch exhibited a small photographic camera, with a number of small pictures made with it and enlargements of the same. He spoke briefly of its convenience and adaptability to field uses.

Barton W. Evermann reported that a wireless message had just been received from Agent Lembkey at the Pribilof Islands in which it was stated that the reindeer herds on St. Paul and St. George had increased during the past year from 37 to 65 animals and that all are in excellent condition.

The regular program consisted of two communications:

Notes on the Biology of the Common Termites of the Eastern United States: Thomas E. Snyder.

This paper was illustrated by many lantern slides and was discussed by E. A. Schwarz.

The Biting Powers of Ants: W. L. McAtee.

The speaker's personal observations as well as instances gathered from many sources were cited to show the powers of these small animals. Messrs. E. A. Schwarz, A. C. Weed, A. D. Hopkins and the author of the paper took part in the discussion which followed.

The 507th regular meeting was held February 8, with President Nelson in the chair and 57 persons present.

Professor Burt G. Wilder gave an illustrated lecture on "The Brain as a Guide to the Affinities of Vertebrates," basing his remarks primarily on the brain of the shark *Pentanchus* recently described by Smith and Radcliffe as the type of a new family. The speaker showed by means of diagrams the evolution of the selachian brain from the most primitive form found in *Chlamydoselachus* through the other Notidani to the typical sharks; and announced his conclusion, from the evidence afforded by the brain, that *Pentanchus* is not a notidanid. He did not venture, however, to say just what the systematic position of this shark may be until the vertebræ and intestine have been studied, although it is certainly not related to the Scylliorhinidæ, to which Regan[1] assigns it on the theory that the single dorsal fin is an abnormality.

In the discussion which followed, H. M. Smith said that in assigning *Pentanchus* to the order of ancient sharks, partly on account of the single dorsal fin, he and Mr. Radcliffe had been aware of characters in which this shark differs from typical Diplospondyli, but that no other course seemed expedient at the time the preliminary description was published. The vertebræ, while not diplospondylous, but modified cyclospondylous, are of a very primitive type, being only half the size of those in a scylliorhinid shark of the same length, with an extremely small centrum and a very large neural canal.

Theodore Gill discussed the subject at length, and agreed with Professor Wilder in attaching great taxonomic importance to the brain in sharks and rays. He had concurred in the assignment of *Pentanchus* to the Notidani, and now regarded it as the type of a peculiar family whose affinities remain to be determined.

D. E. Lantz,
Recording Secretary

[1] Science, July 19, 1912.

SCIENCE

FRIDAY, MARCH 21, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

AVOGADRO'S LAW AND THE ABSORPTION OF WATER BY ANIMAL TISSUES IN CRYSTALLOID AND COLLOID SOLUTIONS[1]

I. STATEMENT OF THE PROBLEM

FIFTEEN years ago, on an occasion similar to this, the writer stated that if the constitution of matter is the main problem of the physicist the constitution of living matter is the main problem of the biologist. To-day I will discuss the applicability of Avogadro's law, one of the most fundamental laws underlying the constitution of matter, to a group of life phenomena, namely the regulation of the amount of water in animal cells and tissues. According to Avogadro's law equal volumes of gases at the same temperature and pressure contain an equal number of molecules; or, in other words: In the gaseous state equal numbers of any kind of molecules enclosed in equal volumes have the same pressure at the same temperature. This law was extended to solutions by van't Hoff in the following form: All dissolved substances produce upon a membrane which prevents their diffusion but allows water to diffuse an osmotic pressure equal to that which would be produced by gaseous matter containing the same number of molecules in the same volume. Combining Avogadro's and van't Hoff's law we may state that the same number of molecules of any kind of matter produce at the same temperature and volume the same pressure upon the walls which prevent their diffusion.

[1] Read by title in the Botanical Section of the Cleveland meeting of the Society of American Naturalists, December, 1912.

It is well known that Pfeffer constructed cells of clay whose pores were filled with a precipitate of ferrocyanide of copper and that the walls of these cells allowed water, but not salts or sugars, to diffuse through. When such a cell with semi-permeable walls is filled with a salt or sugar solution and put into a larger vessel containing distilled water, the latter will diffuse into the cell and raise the level of the liquid until the hydrostatic pressure is equal to the osmotic pressure of the solute. Such a cell could therefore be used for the determination of the molecular weight of any dissolved substance which can not pass through its walls.

Now, if it be true that living cells are surrounded by semi-permeable walls and that the osmotic pressure regulates the exchange of water between the cells (or tissues) and the liquids of the animal body, it should also be possible to use living cells as osmometers for the determination of the molecular weight of sugars or salts.

The reader is aware that this possibility had already been demonstrated for plant cells (*Tradescantia*) by de Vries before van't Hoff had discovered the applicability of Avogadro's law to liquids and that de Vries's observations induced van't Hoff to interest himself in this problem. At the time of de Vries's work there was a difference of opinion concerning the molecular structure of the sugar raffinose and three different formulæ were offered, one giving the sugar the molecular weight 396, the second 594 and the third 1,188.

By determining the concentrations of cane sugar and raffinose which cause plasmolysis, *i. e.*, the shrinking of the protoplasm of the *Tradescantia* cells, de Vries found that a 3.42 per cent. cane sugar solution and a 5.96 per cent. raffinose solution had the same physiological effect. On the basis of the assumption that solutions with an equal attraction for water have the same number of molecules in equal volumes, and since the molecular weight of cane sugar is 342, the molecular weight of raffinose should be $(5.96/3.42) \cdot 342 = 596$. In this way it was established by de Vries that the molecular weight of raffinose was 594 and the formula $C_{18}H_{32}O_{16} + 5H_2O$ the correct one.[3] This formula for raffinose is to-day accepted by the chemists.

II. Examples for the Applicability of Avogadro's Law to the Osmotic Behavior of Animal Tissues

The oldest and, perhaps, best demonstration of the fact that the exchange of water between animal cells and the surrounding liquid is determined by Avogadro's law is furnished by Hedin's experiments on red blood corpuscles. His method consisted in the determination of the changes of volume of red blood cells in various solutions. The volume was determined with the centrifuge.

Hedin[4] first established the fact that the blood cells do not change their volume if put into solutions of the same molecular concentration as the blood, no matter what the nature of the solution, provided that the substance does not enter the cell.

Volume of Blood Corpuscles in

.15m	KNO_3	NaCl	$NaCH_3COO$	$CaCl_2$
	34.4	34.4	34.3	34.3

All the solutions had the same osmotic pressure as a .15m KNO_3 solution. The agreement of the results is such that the use of red blood corpuscles as osmometers for the determination of the molecular

[3] After Hoeber, *Physical. Chemie d. Zelle u. Gewebe*, 1911, p. 86; De Vries, *Jahrb. f. wissensch. Botanik*, Vol. 14, p. 427, 1884.

[4] Hedin, *Skand. Arch. f. Physiologie*, Vol. 5, pp. 207 and 238, 1895. (The tables quoted here are taken from Hamburger, "Osmotischer Druck und Ionenlehre.")

weight of dissolved substances would be warranted.

The following gives the results of the change in the volume of red blood corpuscles in isosmotic concentrations of KNO_3 and NaCl.

Concentration	Volume of Blood Corpuscles in		Difference, Per Cent.
	KNO_3	NaCl	
.08m	48.6	50.2	—1.6
.1	46.3	48.2	—1.9
.12	43.2	44.2	—1.0
.13	42.5	43.4	—0.9
.14	41.4	42.2	—0.8
.15	40.2	41.0	—0.8
.16	39.9	40.4	+0.5
.17	39.7	39.6	+0.1
.18	39.4	39.2	+0.2
.20	39.1	38.0	+1.1
.22	39.2	37.3	+1.9
.24	38.7	36.8	+1.9
.26	38.3	36.5	+1.8
.30	37.2	36.8	+0.4

The agreement is best for .17 KNO_3 which was equi-molecular with the blood used in this case.

But even for concentrations differing from the molecular concentration of the blood the agreement is still surprisingly satisfactory, considering the fact that solutions which differ widely in their concentration from that of the blood corpuscles are liable to modify the permeability of the cells, as we shall see later; and that this injurious effect is influenced strongly by the chemical nature of the substance.

We may, therefore, state that equi-molecular solutions of salts cause practically the same change in the volume of red blood corpuscles.

The experiments on red blood corpuscles have the disadvantage that we can not well discriminate between the living and dead cell. In this respect the experiments on muscle are much more satisfactory. It had been known through the experiments of Nasse that in an m/8 solution of NaCl (and other salts of Na) the frog's muscle keeps its weight. The writer showed sixteen years ago that (within certain limits of time) the same is true for solutions of LiCl, KCl, $MgCl_2$, $CaCl_2$, $SrCl_2$ and $BaCl_2$ equi-molecular with an m/8 NaCl solution, while in solutions of lower concentration the muscle absorbs, in solutions of higher concentration it loses water. He concluded from this that the absorption of water by the muscle is determined by van't Hoff's law.[4] The number of molecules in solution, and not their chemical character, determines the exchange of water between muscle and surrounding solution.

I was interested to find out with what degree of accuracy Avogadro's law determines the exchange of water in the muscle. For this purpose a series of experiments were made with NaCl and various sugars in concentrations slightly below or above the point of isotony.

CHANGE IN WEIGHT OF A FROG'S MUSCLE WITHIN ONE HOUR IN PER CENT. OF ITS ORIGINAL WEIGHT IN

.1	.125	.150	.175m NaCl
+ 3.9%	0%	— 1.9%	— 1.9%

In a .1m solution of NaCl the muscle takes up water, in a .125m solution it keeps its weight, in a .15 solution it loses water. That the loss in a .175m solution was in this case not greater than in a .15 solution was accidental and probably due to the fact that different muscles vary somewhat in their osmotic pressure, owing to their previous history—*e. g.*, whether they had been more or less active. The influence of these inequalities can be eliminated by making a large number of experiments.

But, although the muscle is not quite as accurate an osmometer as the red blood corpuscles, the fact that its exchange of water is determined primarily by Avo-

[4] Loeb, *Pflüger's Archiv*, Vol. 69, pp. 14–20, 1897.

gadro's law is illustrated by the following experiment.

In an m/8 solution of NaCl 85 per cent. of the molecules are dissociated into ions. If we want to prepare solutions of non-conductors (*e. g.*, sugars) of the same osmotic pressure as an m/8 NaCl we must choose a concentration of .231m. At a concentration of a sugar solution of .200m a muscle must absorb water, while at a concentration of .250 and above it must lose water. We have made this experiment for three sugars, a mono-saccharide, grape sugar; a disaccharide, cane sugar; and a trisaccharide, raffinose. The following table gives the change in weight of the muscle in these solutions in one hour.

	.2m	.25m	.3m	.35m
Grape sugar	+2.9%	−1.6%	−4.1%	−7.7%
Cane sugar	+3.8%	−1.2%	−1.3%	−6.1%
Raffinose	+1.7%	−3.3%	−5.3%	−8.9%

The turning point between loss and gain of weight lies for all those sugars between the same limit of molecular concentration, namely, between .2 and .25m; and the most important fact is that the value for the three different sugars lies between the limits calculated on the assumption that the exchange of water between muscle and surrounding solution is determined by Avogadro-van't Hoff's law. As long as we are dealing in biology with only qualitative results there may always be some doubt in regard to the applicability of such a law to a life phenomenon, but if the results come out quantitatively identical with those calculated we may be pretty sure that the law holds good for these cases.

Miss Cooke[5] investigated in the writer's laboratory the gain of weight in the muscle in hypotonic and hypertonic NaCl solutions. Near the isotonic point the amount of water increases at first slowly in almost a straight line with the dilution; but as the solutions become more dilute the amount of water taken up increases at a rate far greater than the rate of dilution of the solution. Miss Cooke points out that this may be due to some secondary change in the muscle caused by the dilute solution or the entrance of water into the muscle. In hypertonic solutions irregularities were noticeable, due probably to the varying condition of rest or activity in the individual muscle before the experiment.

The following gives a series of determinations in equi-molecular solutions of NaCl and cane sugar, by R. Webster.[6]

CHANGE IN WEIGHT OF FROG'S GASTROCNEMIUS AFTER ONE HOUR IN EQUI-MOLECULAR SOLUTIONS OF NaCl AND CANE SUGAR.

NaCl		Cane Sugar	
	Per Cent.		Per Cent.
m	−17	1.67m	−40
m/2	−13	.87m	−27
m/4	− 7	.45m	−12
m/8	0	.23m	− 1
m/16	+13	.12m	+11
m/32	+25	.06m	+26

While the gain in weight of the muscle in the equivalent hypotonic solution is practically the same in NaCl and cane sugar, in the hypertonic solutions of cane sugar the muscle loses more than in the equi-molecular solutions of NaCl. This is probably due to the fact that solutions of cane sugar have an abnormally high osmotic pressure and that this anomaly seems to be more pronounced the higher the concentration.

The number of animal organs in which the applicability of Avogadro's law can be tested is limited, since for this purpose it is necessary that the tissues have no pores or capillary spaces in which the surround-

[5] *Journal of Physiology*, Vol. 22, p. 137, 1898.

[6] R. Webster, University of Chicago Decennial Publications, Vol. X., p. 105, 1902.

ing solution can adhere. Tissues with a spongy structure can not be used for exact measurements. Siebeck[7] has recently been able to carry out a series of experiments on the kidneys of the frog. The measurements were not as satisfactory as in the case of the red blood corpuscles and the muscle, but sufficiently accurate to leave no doubt of the main result, which is as follows: In solutions of NaCl, NaBr, LiCl, and LiBr, KCl, $CaCl_2$, $MgCl_2$ and cane sugar equi-molecular with a .7 per cent. Ringer solution the kidneys neither take up nor lose water. Siebeck points out that these solutions have no other quality in common except the same number of molecules, and that hence the osmotic pressure determines the exchange of water between the kidneys and the surrounding solution. Mathews's experiments indicate that the same is true for the living nerve.[8]

According to Meigs[9] smooth muscle preparations do not behave as if they were surrounded by semi-permeable membranes; but the smooth muscle of the stomach which he used in his experiments can not be obtained in as natural a condition as that in which striped muscle or blood corpuscles or the kidneys are available. It would be of interest to repeat these experiments on smooth muscle, which can be obtained with as little alteration of its natural surface, as, *e. g.*, striped muscle or kidneys or red blood corpuscles.

III. ABSORPTION OF WATER BY COLLOIDAL SOLUTIONS

The natural media surrounding animal tissues are solutions which contain dissolved proteins in addition to certain salts. Some authors seem to take it for granted that the force by which such protein solutions or colloidal solutions in general absorb water is not determined by Avogadro's law, and some go so far as to state that the regulation of the distribution of water between cells and blood is solely determined by the proteins and not by the salts. Such ideas are contradicted by theory as well as by experiment. We can show by the use of living cells as osmometers that colloidal solutions behave exactly as Avogadro's and van't Hoff's laws demand.

Avogadro-van't Hoff's law demands that a grammolecular solution of any dissolved substance contain the same number of molecules—leaving aside temporarily the facts of dissociation—and this number N is Avogadro's constant. As is well known, the value of N has been determined for molecules with an astonishing degree of agreement by the most diverse methods. Thus Rutherford found $N = 62.10^{22}$ by counting the α particles given off by a given quantity of radium per second; and Dewar as well as Boltwood obtained identical values, 71.10^{22}, by a similar method.

A method of calculating N from the constants of heat radiation gave, according to a theory of Lorentz, $N = 62.10^{22}$. Lord Rayleigh determined the number N of molecules in a grammolecule from the diffusion of light from the sky and found N about 70.10^{22}.[10]

It would seem *a priori* perhaps doubtful whether or not the suspended particles of a colloidal solution behave like molecules. Perrin undertook to solve this problem. He points out that van't Hoff's law (for properly dilute solutions) is applicable, no

[7] Siebeck, *Pflüger's Archiv*, Vol. 148, p. 443, 1912.

[8] A. P. Mathews, *Am. Jour. Physiol.*, Vol. II., p. 455, 1904.

[9] *Journal of Exper. Zoology*, Vol. 13, p. 498, 1912.

[10] These data are taken from Arrhenius, "Theories of Solutions," New Haven, 1912, pp. 25 and 26.

matter whether molecules are small or large, light or heavy.

Can we not suppose under these circumstances that there is no limit of size for the particles which obey this law? Should it not be possible that even visible particles obey this law exactly, so that a granule, agitated by brownian movement, counts neither more nor less than an ordinary molecule in regard to the action of its shocks on a wall which blocks its progress? Or, in other words, may we not assume that the laws of perfect gases can be applied to emulsions made of visible granules.[11]

It is well known that Perrin determined the value of N from the measurement of the relative distribution of the suspended particles of an emulsion of mastix in a vertical column and found $N = 62.2 . 10^{22}$. Almost identical values were obtained by him by three other methods. This proves that as far as osmotic pressure is concerned the suspended particles of an emulsion behave exactly like the molecules of a gas.

Direct osmometric measurements of the osmotic pressure of proteins gave very low figures, as was to be expected from their high molecular weight. R. S. Lillie found 30 to 40 mm. Hg for a 2 per cent. solution of albumen,[12] Starling for the proteins of blood serum 40 mm. Hg.

The question may now be asked whether or not the proteins in solution have other qualities by which they attract water than their osmotic pressure? This question can easily be answered by using living cells as osmometers. We have seen that an m/8 NaCl or a .231m sugar solution are isotonic with a frog's muscle (gastrocnemius). The latter solutions have an osmotic pressure of 3933 mm. Hg. We have also seen that as an osmometer a frog's gastrocnemius may be considered accurate at the point of isotony within .03m sugar. Hence the osmotic pressure of the proteins of the blood is below the limit of sensitiveness of the muscle as an osmometer; or, in other words: if the attraction of water by blood is determined solely by the osmotic pressure of the blood that part of its total osmotic pressure which is furnished by the proteins must be negligible. This is indeed the case.

I asked my assistant, Dr. Beutner, to compare the change in weight of a frog's muscle in various solutions with and without proteins.[13]

CHANGE IN WEIGHT OF TWO GASTROCNEMII OF THE SAME FROG

	Muscle *a* in m/8 Ringer, Per Cent.	Muscle *b* in m/8 Ringer + 2 Per Cent. Gelatine. Per Cent.
After 1 hour	— 1.6	— 2.5
After 3 hours	— 3.5	— 4.3
After 8 hours	— 3.2	— 4.7
After 22 hours ...	— 4.4	— 3.8
After 29 hours ...	— 4.2	— 3.8

The differences in the two rows of figures are slight in comparison with the experimental errors and show that the addition of gelatine does not influence noticeably the absorption of water.

In a second experiment it was ascertained that in blood serum which was freed from the greater part of its salts by dialyzing it for 40 hours through parchment paper the muscle gains exactly as much in weight as it does in a NaCl solution of the same osmotic pressure. The serum had after dialyzation a freezing point depression of .03°, corresponding to a concentration of NaCl of about m/120.

CHANGE IN WEIGHT OF TWO GASTROCNEMII OF THE SAME FROG

	Muscle *a* in Dialyzed Serum, Per Cent.	Muscle *b* in m/120 Ringer, Per Cent.
After ½ hour ...	+ 22.3	+ 24.7
After 1 hour ...	+ 34.0	+ 38.0
After 2½ hours .	+ 51.0	+ 53.6

[11] Perrin, "Les Atomes," Paris, 1912, p. 128 ff.

[12] Lillie, *Am. Jour. of Physiol.*, Vol. 20, p. 127.

[13] R. Beutner, *Biochemische Zeitschr.*, Vol. 48, p. 217, 1913.

These two series of results may be considered as identical within the limits of error. They prove that proteins in solution attract water from the muscle solely according to their osmotic pressure and not according to any other real or assumed quality. They prove also that the salts and not the proteins of the blood determine the exchange of water with the tissues.

R. Lillie has shown that the addition of acid increases the osmotic pressure of a protein solution, but the increase is too small, even in dialyzed serum, to influence the velocity of water absorption, as the following figures show.

CHANGE IN WEIGHT OF TWO MUSCLES

	Muscle *a* in 50 c.c. Dialyzed Serum +1 c.c. N/10 HCl, Per Cent.	Muscle *b* in Dialyzed Serum without Acid, Per Cent.
After 1 hour ...	+ 33.0	+ 35.0
After 2 hours ..	+ 43.0	+ 46.0
After 4 hours ..	+ 52.0	+ 49.0
After 6 hours ..	+ 45.0	+ 43.0

I think all these experiments prove conclusively, (1) that colloidal solutions influence the absorption of water in the tissues solely by their osmotic pressure; and (2) that this osmotic pressure is so small in comparison with that of the salts in the liquids of the body that their influence is in general practically negligible.[14]

IV. PERMEABLE AND NON-PERMEABLE SOLUTES

The existence of semi-permeable walls which allow the water but not the solute to diffuse is the prerequisite for the manifestation of osmotic pressure. It is well known that Overton showed that dissolved substances which diffuse easily into the cell do not produce any osmotic effect. The permeability of cell walls for alkaloids can be directly demonstrated by their reaction with the tannic acid of the cells, and Overton showed that when added to an isotonic salt solution the alkaloids will not alter the water equilibrium. The substances which thus diffuse readily into the cells are alcohols, aldehydes and many other compounds which often show a relatively high degree of solubility in lipoids. The difference in the behavior of substances which are soluble in the cell wall (like alcohol) and non-soluble (like sugar) is illustrated by the following experiments by Overton.[15]

In 0.2 per cent. NaCl + 2.66 per cent. mannit (together equi-molecular with .7 per cent. NaCl) the gastrocnemius of a frog kept its weight for nine hours unaltered. In 0.2 per cent. NaCl + 2 per cent. methyl alcohol (approximately equi-molecular with a 1.6 per cent. NaCl solution), the muscle absorbed water as powerfully as in a pure 0.2 solution of NaCl. Only those substances which can not diffuse into the cell can assist in the exchange of water between tissues and the liquids of the body; exactly as Avogadro's law demands.

It is generally assumed that there is only one type of semi-permeable membranes, namely, those permeable for water, but not for neutral salts or sugars. This type is the most common. But there are at least two other types of semi-permeability. Some membranes are permeable for water as well as salts and sugars, but not for colloids. The fertilization membrane of the sea urchin egg (*Strongylocentrotus*

[14] The erroneous idea that the attraction of water by blood serum is determined by proteins may have originated through the arbitrary assumption that the phenomenon of imbibition found in solid colloids is retained by the colloids in solution. This reasoning is, however, not warranted, since it is possible that in solid colloids conditions for the absorption of water may exist which cease to exist when the colloid is dissolved.

[15] Overton, *Pflüger's Archiv*, Vol. 92, p. 115, 1902.

purpuratus) belongs to this type.[16] On the other hand, there are membranes which are neither permeable for salts nor for water. This type of membranes is represented by the eggs of *Fundulus*, and apparently *Fundulus* itself, and probably by a large number of other aquatic vertebrates.

All these membranes are, however, permeable for gases (O_2 and CO_2) dissolved in water.

V. THE APPARENT CONTRADICTION BETWEEN THE PHYSIOLOGICAL EFFICIENCY OF SALTS AND THE SEMI-PERMEABILITY OF CELL WALLS

We will now discuss a difficulty which the idea of impermeability of the cells for salts has to meet. In a pure NaCl solution the frog's muscle begins to twitch, while the addition of a little Ca inhibits this effect. It is difficult to assume that salts act without diffusing into the cell, and yet the phenomena of isotony are incomprehensible without the assumption of practical impermeability of the cell for salts and sugars. This difficulty is apparently relieved by the investigations of Loeb and Beutner[17] on the potential differences at the limit between living organs and the surrounding solution of electrolytes. If we form a cell of the type: solution of electrolyte (concentrated); living organ; solution of electrolyte (dilute), the dilute solution is positive towards the concentrated; and the more so the greater the dilution. This seems to be a fact for most living tissues. From this it follows that living tissues are reversible for kations. We were, moreover, able to show that the electromotive forces of such cells obey Nernst's law, according to which the E.M.F. varies with the logarithm of the concentration. But the most surprising fact we found was that the living cells are reversible in regard to practically any kation, while the potential differences heretofore observed by physicists at the limit of two phases were only reversible for one kation. These results are only intelligible on one of two assumptions: either the surface of all living organs contains already traces of all metals, which is not very probable; or traces of the electrolytes react with the surface of the living organ. If the latter is true we can understand that electrolytes can influence the life phenomena and yet produce the theoretically calculated osmotic pressure upon the walls of living organs.

The writer suggested thirteen years ago that chemical reactions occur between the electrolytes and certain parts of the "protoplasm"—proteins or fatty compounds—which result in the formation of ion or metal-proteins or soap-like compounds, and that these reactions explain the influence of the electrolytes upon muscular twitchings, heart beat, etc. It is well known that the action of salts like NaCl or $CaCl_2$ or KCl upon the heart beat or muscular twitchings is—within certain limits of concentration and time—perfectly reversible, and this reversibility is characteristic of this action. Such a complete reversibility of chemical reactions is intelligible if only traces of the salts enter into reaction with the substances contained in the living organ.

Beutner reached the conclusion on the basis of thermodynamical calculations that the potential differences observed by us at the junction of living organs and surrounding solution demand the assumption of a chemical reaction between traces of

[16] Loeb, *Roux's Archiv*, Vol. 26, p. 82, 1908.

[17] Loeb and Beutner, *Biochemische Zeitschr.*, Vol. 41, p. 1, 1912; Vol. 44, p. 303, 1912.

the electrolyte and the surface of the living organ.[18]

VI. THE ALTERATION OF THE SEMI-PERMEABILITY OF CELL WALLS BY ELECTROLYTES

Those who have worked with Pfeffer's semi-permeable cells report that it is very difficult to maintain cells in the state of ideal semi-permeability. It seems that the semi-permeability of living organs suffers also if they are exposed to solutions abnormal in concentration or constitution or both. The normal medium for the cells of our body is a liquid which contains NaCl, KCl and $CaCl_2$ in a proportion which is almost identical with the one in which those salts appear in the ocean. In such solutions, if their concentration is right, the cell walls may keep their specific semi-permeability as long as they live. If, however, the cells or organs are put into solutions of other salts, or of solutions with only one of the three salts just mentioned, the semi-permeability is lost sooner or later and death follows. The possible explanation is that the interactions between salts and surface of the living organ lead in this case to a modification of the physical qualities of the surface of the living organ.

In 1899 the writer found that the newly fertilized eggs of a marine fish, *Fundulus*, will develop normally in distilled water and the fish will hatch. If, however, the eggs are put into an m/2, or still better ⅝m, NaCl solution immediately after fertilization they will die without forming an embryo. If a small but definite amount of a salt with a bivalent metal is added to the NaCl solution the eggs will form embryos. The explanation of these facts is as follows:

If the newly fertilized eggs are put into a ⅝m NaCl solution the NaCl makes the egg membranes, which are naturally impregnable to salts, gradually permeable. NaCl enters the egg and the germ is killed. If a little Ca is added to the NaCl this modification of the membrane is inhibited, no NaCl enters the egg and the germ can live and develop. In distilled water the membrane remains also impermeable to salt (and to water) and the embryo likewise develops.[19]

The writer has recently published a series of experiments which furnish a proof for this assumption.[20] Only the general character of this proof can be indicated here. The eggs of *Fundulus* have a specific gravity of a little over 1.0580 (corresponding to 1⅛m NaCl solution). If such eggs several days after fertilization are put into a 3m solution of NaCl + KCl + $CaCl_2$ in the proportion in which these three salts occur in the sea-water, the eggs will float at the surface of the solution for four days or longer. Then they will shrink and fall to the bottom of the test tube. The membrane is impermeable to water and salts and remains so for a series of days even in a 3m solution of NaCl + KCl + $CaCl_2$. Finally it becomes permeable for water and to a lesser degree for salts and the eggs shrink and fall to the bottom. If, however, the eggs are put into a 3m solution of NaCl they will also float at first; but the increase in permeability and the shrinking begins in three hours. If we put the eggs into a solution of $CaCl_2$ from 1⅝m to 2½m they float at first, but the shrinking begins in 20 minutes and the eggs sink to the bottom. If we put the eggs into a mixture of 48 c.c. 3m NaCl + 2 c.c. 1⅝m $CaCl_2$ they will

[18] Beutner, *Biochem. Zeitschr.*, Vol. 47, p. 73, 1912.

[19] Loeb, SCIENCE, Vol. 34, p. 653, 1911. Reprinted in "Mechanistic Conception of Life," Chicago, 1912; *Pflüger's Archiv*, Vol. 107, p. 252, 1905.

[20] Loeb, *Biochemische Zeitschr.*, Vol. 47, p. 127, 1912.

float for three days, before they begin to shrink and fall to the bottom. This and similar experiments show that the specific semi-permeability of an animal membrane is influenced by the nature of the solutions to which it is exposed. In physiologically balanced solutions, *e. g.*, $NaCl + KCl + CaCl_2$ in the proportion in which these salts exist in the sea-water, this specific semi-permeability is preserved longest, if not permanently. In solutions of one salt only the permeability is as a rule increased as soon as the concentration of the salt in the solution exceeds a certain limit. This limit varies for different salts and varies also for the same salt in different animals. This is the reason why a pure NaCl solution becomes injurious more rapidly to one form of organism than to another. The reader will notice that in this field of phenomena the chemical nature of the solution is of primary importance.

This dependence of the preservation of semi-permeability upon the chemical nature of the surrounding solution suggests the possibility of a chemical interaction between cell walls and surrounding solution in which the chemical and physical properties of the semi-permeable wall are modified.

VII. THE DIFFERENCE IN THE MODE OF ABSORPTION OF WATER IN LIVING AND DEAD CELLS

We may conclude from the preceding data that the salts of the surrounding solution react chemically with the colloids of the surface of the cell and that the products thereby formed determine the degree of permeability or impermeability of the cell walls.

These changes vary with the chemical nature of the salt. In some solutions the permeability is preserved much longer than in others. Thus the muscle keeps its normal function much longer in a NaCl or a LiCl solution than in a solution of KCl or $CaCl_2$. As long as the muscle is irritable or even some time after it ceases to be irritable it obeys Avogadro's law in the solutions of pure salts. After 18 hours, however, the muscle is killed in pure isotonic solutions of KCl as well as of $CaCl_2$, while it is still alive in solutions of NaCl and LiCl. At that time it continues to obey the law of Avogadro in NaCl and LiCl, but no longer in KCl and $CaCl_2$.

CHANGE IN WEIGHT OF A GASTROCNEMIUS OF A FROG AFTER 18 HOURS IN SOLUTIONS EQUIMOLECULAR WITH m/8 NaCl[31]

	Per Cent.		Per Cent.		Per Cent.		Per Cent.
LiCl...	—1	NaCl..	+ 6	KCl..	+45.7	$CaCl_2$...	—20
LiBr...	—1	NaBr..	+ 7	KBr...	+41		
LiJ....	—3	NaJ...	+10	KJ.....	+45		

While the muscle undergoes no, or only slight, changes in weight in the isotonic solutions of Na and Li salts it absorbs a considerable amount of water in KCl, loses water in $CaCl_2$.

Overton, who later repeated and confirmed these results, explained them on the assumption that the normal muscle is permeable for KCl, but not for the other salts. In a pure KCl solution the salt gradually enters the muscle, whereby the osmotic pressure of the muscle is increased and the latter swells; while in a $CaCl_2$ solution the KCl naturally contained in the muscle leaves the muscle and the diminution of the number of molecules in the muscle makes the surrounding originally isotonic solution hypertonic for the muscle. One fails to see, on such an assumption, why the muscle does not also lose water in a NaCl solution. It has been demonstrated

[31] Loeb, *Pflüger's Archiv*, Vol. 75, p. 304, 1899; "Studies in General Physiology," Vol. II., p. 511, Chicago, 1906.

that the normal gastrocnemius of a frog contains little or no NaCl, but comparatively much KCl, while in the blood the reverse is the case. From this it has been plausibly argued that the NaCl of the blood can no more enter the muscle than can $CaCl_2$. One fails, however, to see how on this assumption the fact can be explained that in a pure NaCl or LiCl solution the muscle keeps its weight or gains slightly, while in $CaCl_2$ it loses considerably in weight, since in a pure NaCl solution the K-salts should leave the muscle as well as in a $CaCl_2$ solution.

In all hypertonic solutions the muscle loses water and the higher the concentration of the solution is the more water it loses. This is what should be expected according to Avogadro's law. But the writer noticed that if the muscles remain in the hypertonic solution they begin after a certain time to absorb water and the higher the concentration the sooner, so that finally the muscle begins to swell even in a grammolecular solution of NaCl!

This paradoxical behavior finds its explanation in the writer's observations on *Fundulus* eggs, which show that the impermeability of the membrane for salts and sugars is destroyed the more rapidly the higher the concentration of a solution. As soon as this impermeability is destroyed the cells no longer follow Avogadro's law, but show a behavior which is comparable to that of a piece of solid gelatine, *i. e.*, water is absorbed not by osmotic forces but by "imbibition." The degree of imbibition varies with the nature of the surrounding salt and on this assumption the writer explained the differences of behavior of dead muscle in KCl and $CaCl_2$ solutions.[23]

[23] Loeb, *l. c.*

VIII. THE ANTAGONISM BETWEEN ACIDS AND SALTS

The influence of the chemical character of the surrounding solutions upon imbibition in the dead muscle is well illustrated by the following observations:

The writer showed sixteen years ago that the muscle absorbs water from an m/8 solution of NaCl if HCl (or any other acid) is added.[24] In this case the law of Avogadro-van't Hoff is apparently violated. It was pointed out by Overton that in this case the acid destroys the semipermeability of the muscle and that the subsequent absorption of water was a mere phenomenon of imbibition. It had been shown previously that the swelling of a solid plate of gelatine in water is increased if acid is added.

In a subsequent paper it was shown by the writer that there exists a curious antagonism between salts and acids. While a muscle swells in an m/8 NaCl solution if the latter is rendered acid, it does not swell, or it may be even dehydrated in an acid solution when the concentration of the NaCl in the solution is sufficiently raised; notwithstanding the fact that in the highly concentrated *neutral* NaCl solution the muscle will finally absorb water.

The following table illustrates this:

Neutral NaCl		m/110 HCl in NaCl	
Concentration of NaCl, Per Cent.	Increase in Weight in 18 Hours, Per Cent.	Concentration of NaCl, Per Cent.	Increase in Weight, Per Cent.
4.9	+6	4.9	—36
1.22	—2	1.22	+22.2
0.7	+7	0.7	+40

While the muscle gains in weight in eighteen hours in a neutral 4.9 per cent.

[24] Loeb, *Pflüger's Archiv*, Vol. 69, p. 1, 1897; Vol. 71, p. 457, 1898. "Studies in General Physiology," Vol. II., pp. 450 and 501, Chicago, 1906.

NaCl solution, it loses considerably in an m/110 acid 4.9 per cent. NaCl solution.[24]

The writer also pointed out that the chemical character of the salt was of great influence in this phenomenon. While it required a high concentration of NaCl and of acid to cause a dehydration, the same was accomplished by a much weaker solution of K_2SO_4. In a neutral isotonic solution of K_2SO_4 the muscle lost 4 per cent. in eighteen hours, but when 10 c.c. m/10 HCl were added to 100 c.c. isotonic K_2SO_4 solution the muscle lost 22 per cent. of its weight! The concentration of K_2SO_4 required to inhibit the swelling effect of the acid is therefore much smaller than that of NaCl.[25]

When a muscle is put into a .04 solution of Na_2SO_4 which is rendered m/200 acid through the addition of H_2SO_4 the muscle first absorbs water and later is dehydrated, as the following experiment by Beutner[26] shows:

CHANGE IN WEIGHT OF MUSCLE IN .04m Na_2SO_4 — N/200 H_2SO_4

1 hour	+ 9.9
3 hours	+ 12.3
6 hours	+ 1.8
24 hours	— 19.3
32 hours	— 25.2
96 hours	— 31.2

The interpretation of this result offers no difficulty. As Beutner pointed out, the muscle obeys the law of van't Hoff, as long as it is alive, or more correctly, as long as the semi-permeability of its membrane is preserved. Since a .04m solution of Na_2SO_4 is hypotonic, the muscle must absorb water in such a solution. As soon as the semi-permeability of the muscle is lost and the acid diffuses into the muscle it behaves altogether differently, namely, like a piece of gelatine. Proctor has shown that solid gelatine swells in a salt solution as well as in an acid solution, while it is dehydrated in a combination of both; and the same is true for the dead muscle.

IX. INTERNAL CHANGES IN THE MUSCLE

Miss Cooke showed that the fatigued muscle of a frog is no longer isotonic with an m/8 solution of NaCl, but with a 3m/16 solution. The fatigue has, therefore increased the osmotic pressure of the muscle.[27] The writer suggested that in this case lactic acid was formed and that this lactic acid was the cause of the absorption of water by the muscle in an isotonic solution.[28] The lactic acid might act as a catalyzer in certain reactions, whereby the osmotic pressure would be raised in the muscle. Others assume that some colloid in the muscle is caused to swell by the acid. This could only refer to some solid colloid. But it is difficult to understand how this could force the muscle to absorb more water. Proctor[29] has shown that solid colloids absorb not only *water*, but also *salts* (even in the presence of acid); if this be the case the swelling of solid colloids inside the muscle can only increase the osmotic pressure of the liquids contained inside the muscle cells, if relatively more water is absorbed than salt. Since no quantitative data are available on this point, it is useless to argue the question.

[24] Loeb, *Pflüger's Archiv*, Vol. 75, p. 302, 1899. Reprinted in "Studies in General Physiology," Vol. II., p. 516, 1906.

[25] Loeb, *Pflüger's Archiv*, Vol. 75, p. 303, 1899; "Studies in General Physiology," Vol. II., p. 514.

[26] Beutner, *Biochem. Zeitschr*, Vol. 39, p. 280, 1912.

[27] In order to avoid misunderstandings it should be said that the fatigued muscle obeys Avogadro's law, only its point of isotony is increased.

[28] Loeb, *Pflüger's Archiv*, Vol. 71, p. 466, 1898.

[29] Proctor, "Kolloidchemische Beihefte," Vol. II., p. 262, 1911.

CONCLUSION

I believe the facts mentioned in this address show that those animal cells or organs which lend themselves to exact measurements of osmotic changes obey the law of Avogadro-van't Hoff, as long as they are normal or alive: *i. e.*, they neither absorb nor lose water if put into solutions of any kinds of sugar or neutral salts which are equi-molecular with the blood; that they absorb water in solutions of lower osmotic pressure, lose water in solutions of higher osmotic pressure. If the law of Avogadro and van't Hoff is correct (which nobody doubts), this behavior of the tissues is the expression of the applicability of this law to the exchange of water between tissues and liquids of the body.

It does not often happen in biology that we are able to reduce life phenomena to a fundamental physico-chemical law to such an extent that we can not only predict the results qualitatively, but also quantitatively, as is the case in the application of Avogadro's law to the exchange of water between tissues and the liquids of the body.

If anybody wishes to supplant the law of Avogadro he must be able to offer a theory which allows a still closer approximation between calculated and observed results than is the case in the experiments on the absorption of water by animal cells or tissues. No such theory has thus far been offered.

JACQUES LOEB

THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH

THE SPREAD OF THE BROWN-TAIL AND GYPSY MOTH

FOR several years Massachusetts has been spending large sums of money in fighting the brown-tail and gipsy moths. These insects have spread westward in their devastating course and are now recorded from a point not far distant from the eastern boundary of New York. In February a conference was called in Boston by the state forester of Massachusetts for the purpose of bringing together not only those actually engaged in the fight with the gipsy and brown-tail moths, but those who are sure to be concerned in the near future. The New York State College of Forestry at Syracuse University is investigating the work of these insects and Dr. M. W. Blackman, forest entomologist of the college, was its representative in the conference in Boston and is ready to take up the fight against these insects when they appear in this state.

Interesting facts were brought out at this conference as to the spread of the gipsy moth. It is very certain that New York and other states about Massachusetts will soon be reached by these destructive insects and that unless more effective means are taken they will destroy not only forest trees but shade and ornamental trees over large sections of the state. As shade tree pests these insects can be controlled by spraying and destroying egg clusters, but these methods are used only at considerable expense and must be continued indefinitely. It seems probable that as soon as the parasites and diseases introduced from abroad which work upon and destroy these insects have become fairly established that they will aid man greatly against future serious outbreaks.

The gipsy moth problem of the future in the state of New York is a forestry problem, as the insect can not be fought in the forest by spraying but must be controlled and eventually eliminated by proper methods of forest management. Certain trees, such as the oak, willow and birch, are apparently more favorable and often seem necessary for the development of the caterpillars of the moths. Methods of forest management can be used which will remove these trees from the forest and thus destroy the most favored food of the pests. With these methods of proper forest management must go strict quarantine against lumber, cordwood and nursery products shipped in from infested areas. Some effort

has been made to establish a "dead line" to prevent further spread of the insect. A zone of timber consisting largely of white pine and other evergreens is selected and all hardwoods or broad-leaf growth removed. As the insects are unable to complete their life history on the pines, they are checked and it may be possible to prevent their spreading northward into the Adirondacks, or into the Catskills, through the maintenance of such zones of coniferous growth. In the caterpillar stage the two moths do the greatest damage and the greatest spread of the insect occurs at this time. They are often blown long distances by the wind or carried by automobiles and other vehicles and much can be done in preventing this kind of distribution by keeping the roadside districts free of the caterpillars through spraying and the removal of their favored food plants.

The outbreak of the gipsy moth in this state in the summer of 1912 was not extensive and by prompt measures, such as the removal of infested trees, spraying, etc., the colony was destroyed. It is entirely possible, however, that there may be other well established colonies in outlying districts near the Catskills or Adirondacks of which there is no official knowledge. The state in the prosecution of its forestry work should make thorough investigations, especially along the eastern border in sections where there is the greater danger of the incoming of the caterpillar and thus prevent its doing the tremendous damage which it has done in Massachusetts.

THE NEW GEOLOGICAL SURVEY BUILDING

AFTER a campaign lasting 26 years the United States Geological Survey has received generous recognition at the hands of congress in the authorization of an expenditure of $2,596,000 for the construction of a fireproof building "of modern office-building type of architecture." With this sum it is proposed to erect a building on ground already owned by the government which shall accommodate, besides the Geological Survey, the Reclamation Service, the Indian Office and the Bureau of Mines, all bureaus of the Interior Department whose work is closely related to that of the Survey and among all of which there is more or less constant cooperation. The public buildings law, which carries the Survey item, authorizes an immediate appropriation of $596,000, the balance to be appropriated as needed in construction. Plans can thus go forward at once for the construction of the new building. For the needs of the Survey and the other bureaus mentioned an up-to-date, conveniently arranged, and well-lighted building is of especial importance. Too many of the civil employees at Washington work in part or exclusively by artificial light, in quarters that may be compared to dungeons, a condition which is suggestive of medieval times, when the first requirement of castles was walls thick enough to resist the attacks of battering rams and catapults, or of the still more ancient period when huge, ornate pillars and columns were the fashion, regardless of the arrangements with respect to light and convenience on the inside of the building. The innovation of providing a structure of the modern office type for government "workshops" in which a maximum of the best work is the first consideration, such as will occupy the new building, will be welcomed.

Mr. Alfred H. Brooks, of the Alaska Division, Mr. Sledge Tatum, of the Topographic Branch, and Mr. Herman Stabler, of the Water Resources Branch, of the Geological Survey, have been appointed an advisory committee to assist the director in regard to the plans for the new building.

SCIENTIFIC NOTES AND NEWS

FOR the meeting of the British Association, which will take place in Birmingham on September 10–17 next, under the presidency of Sir Oliver Lodge, F.R.S., the following sectional presidents have been appointed: A (mathematics and physics), Dr. H. F. Baker, F.R.S.; B (chemistry), Professor W. P. Wynne, F.R.S.; C (geology), Professor E. J. Garwood; D (zoology), Dr. H. F. Gadow, F.R.S.; E (geography), Professor H. N. Dickson; F (economics), Rev. P. H. Wicksteed; G (engineering), J. A. F. Aspinall, M.Eng.; H (an-

thropology), Sir Richard Temple, Bart., C.I.E.; I (physiology), Professor F. Gowland Hopkins, F.R.S.; K (botany), Miss Ethel Sargant, F.L.S.; L (education), Principal E. H. Griffiths, F.R.S.; M (agriculture), Professor T. B. Wood.

THE following fifteen candidates have been selected by the council of the Royal Society to be recommended for election into the society: Professor V. H. Blackman, Dr. William Bulloch, Mr. D. L. Chapman, Professor W. E. Dalby, Dr. T. R. Elliott, Professor J. C. Fields, Dr. J. S. Flett, Professor J. P. Hill, Mr. A. R. Hinks, Professor F. Keeble, Professor A. Keith, Dr. K. Lucas, Professor O. W. Richardson, Dr. W. Bosenhain, and Mr. G. W. Walker.

THE university faculty of Cornell University passed on March 14 the following resolution:

WHEREAS Professor Willard C. Fisher, a distinguished alumnus and former fellow of the university, has been dismissed from the chair of economics and social science at Wesleyan University on grounds stated in the letters of January 27, 1913, exchanged between the president of Wesleyan University and Professor Fisher; therefore, *Resolved*, that the faculty of Cornell University extend to Professor Fisher greetings and assurance of regard, with the message that his *alma mater* still seeks to maintain and extend the spirit of liberality, toleration and loyalty to truth, illustrated by the principles and lives of its founders, Ezra Cornell and Andrew D. White.

ON May 8 the Duke of Northumberland will be installed as chancellor of Durham University in succession to the late dean of Durham. The following are among the honorary degrees to be conferred: D.C.L., Lord Rayleigh; D.Sc., Sir Archibald Geikie, P.R.S., Sir J. J. Thomson, F.R.S., Sir William Crookes, F.R.S., Sir William Ramsay, F.R.S., Sir J. A. Ewing, F.R.S., Sir T. C. Allbutt, and Professor E. B. Poulton, F.R.S.

THE Harris lecture committee of Northwestern University has announced that the Norman Waite Harris lectures for 1913–14 will be delivered by Dr. Edwin Grant Conklin, professor of zoology at Princeton University. The general subject of his lectures will be heredity and eugenics.

DR. LLOYD MORGAN, F.R.S., has been appointed Herbert Spencer lecturer for 1913 at the University of Oxford.

DR. ERNST MACH, professor of physics at Vienna, celebrated his seventy-fifth birthday on February 18.

THE trustees of the Peabody Museum, Salem, Mass., have granted Professor Edward S. Morse a year's leave of absence from the directorship with full salary, in order that he may complete his revision of the New England Mollusca and prepare for publication his Japanese journals.

DR. OSKAR BOLZA, honorary professor of mathematics in the University of Freiburg, who was for eighteen years actively associated with the department of mathematics in the University of Chicago and who is still non-resident professor in that department, will give courses during the summer quarter of the present year.

PROFESSOR CHARLES LANE POOR, of Columbia University, has been given leave of absence for next year. Professor Edward Kasner will have leave of absence during the second half year.

AT the recent meeting of the American Breeders' Association, Dr. David Fairchild, of Washington, was elected president, and Professor W. E. Castle, of Harvard University, vice-president.

OFFICERS of the Association of American Medical Colleges elected at Chicago, on February 26, are: *President*, E. P. Lyon, St. Louis University; *Vice-president*, F. F. Wesbrook, University of Minnesota; *Secretary-treasurer*, F. C. Zapple, University of Illinois.

EDWARD W. BERRY, of the Johns Hopkins University, has been elected a member of the Société Géologique de France.

DR. S. W. STRATTON, director of the United States Bureau of Standards, Washington, D. C., has been elected a member of the council of the Underwriters' Laboratories, Chicago, Ill. The council is made up of twenty-

two leading engineers and experts of the United States and Canada, who serve without recompense and supervise the technical work of the institution.

ARTHUR H. BLANCHARD, M. Am. Soc. C. E., professor of highway engineering, Columbia University, has been appointed by Governor Sulzer a member of the advisory commission on highways for the state of New York.

MR. ANDREW H. PALMER, A.B. (Minnesota, '08), A.M. (Harvard, '09), formerly research assistant at Blue Hill Meteorological Observatory, has been appointed magnetic observer in the department of terrestrial magnetism, Carnegie Institution of Washington.

THE Nantucket Maria Mitchell astronomical fellowship of $1,000 annually has been awarded a second time to Miss Margaret Harwood, A.B. (Radcliffe, '07). Her residence at the Nantucket Observatory is for six months, the remainder of the year is spent in a larger observatory of her own choice. She has elected to continue her researches at the Harvard College Observatory during this semester.

ASSOCIATE PROFESSOR HERBERT E. SLAUGHT, of the department of mathematics in the University of Chicago, has recently become the managing editor of the *American Mathematical Monthly*—a journal for teachers of mathematics in the collegiate and advanced secondary fields.

ON the suggestion of the high commissioner for Cyprus, Sir Ronald Ross is this month visiting the island to investigate the causes of the prevalence of malarial fever.

THE Costa Rica-Panama Boundary Commission, of which Professor John F. Hayford, of Northwestern University College of Engineering, is chairman, is now in session at Northwestern University, compiling the results of the survey and investigations made a little over a year ago to settle the boundary dispute between the two countries. The commission was appointed by Chief Justice White, and the case will be argued before him as soon as the maps and information are complete. Director Hayford is also engaged in a commission for the Carnegie Institution, the result of which is to determine the amount of evaporation of the five great lakes.

THE geological museum of Harvard University is sending G. C. Curtis to Hawaii to collect data for a naturalistic model of Kilauea. Kilauea crater lies within the proposed, and recently surveyed, U. S. National Volcano Park, where the Massachusetts Institute of Technology has recently erected an observatory. Mr. Curtis is the first American geologist to specialize in land relief and has during the past fifteen years brought a new motive and standard into American work. The model of Kilauea will be 12 feet long on the scale of 1:1500, and Museum Curator Sayles expects it to be unique in the contributions to the study of volcanoes.

PROFESSOR JOSEPH S. AMES, director of the physical laboratory, Johns Hopkins University, delivered an address on "Modern Views of the Structure of Matter" before the Science Club of the University of Wisconsin on March 4, 1913.

DR. GEORGE A. DORSEY, curator of anthropology in the Field Museum of Natural History, lectured before the Geographical Society of Chicago on March 14, his subject being "An Ethnologist Abroad."

PROFESSOR C. C. THOMAS, of the University of Wisconsin, lectured on March 6 at the University of Illinois on the subject "Marine Engines." The lecture was one of a series of exchange lectures arranged between the two universities.

DR. F. K. CAMERON, of the bureau of soils, U. S. Department of Agriculture, lectured before the Phi Lambda Upsilon Society at Columbia University on "The Solution of the Potash Problem in America," on March 6.

G. WILLIS MOORE, chief of the Federal Weather Bureau, lectured at Oberlin College on March 12, on "The Story of the Air."

SIR RICKMAN J. GODLEE, president of the Royal College of Surgeons, gave, on March 13, the foundation oration before the University College Union Society on "Lister and his Work."

IT is stated in *Nature* that an exhibition of works by the late Mr. Thomas Woolner, R.A., has been opened at his studios. The exhibits include a number of objects of interest to men of science, among them being plaster busts of Charles Darwin, Huxley and Richard Quain, bronze medallions of Darwin and Sir Joseph Hooker, a colossal head, in plaster, of Captain Cook, and a bronze medal representing science and research. Any works not disposed of during the exhibition will be sold in the studio by auction.

MR. WILBUR WRIGHT bequeathed $50,000 to each of his brothers, Rauchlin Wright and Loring Wright, and to his sister, Katharine Wright. His other property he left to his brother, Orville Wright, "who has been associated with me in all the hopes and labors both of my childhood and manhood, and who will, I am sure, use the property in very much the same manner as we would use it together, in case we should both survive to old age; and for this reason I make no specific bequest to charity."

PROFESSOR ADAM SEDGWICK, F.R.S., formerly professor of zoology at the University of Cambridge, and since 1909 in the Imperial College of Science, London, has died at the age of fifty-seven years.

SIR WILLIAM ARROL, the distinguished British bridge builder, died on February 20, at the age of seventy-four years.

MR. GEORGE MATTHEY, F.R.S., who, while actively engaged in commercial work, made experiments in scientific metallurgy, died on February 14, aged eight-seven years.

DR. M. M. MCHARDY, late professor of ophthalmology in King's College, London, inventor of the registering perimeter which bears his name, died on February 8, at the age of sixty years.

PROFESSOR W. TAIT, in charge of chemistry in the civil engineering college at Sibpur, near Calcutta, died on February 19.

M. ALFRED MAURICE PICARD, the eminent French engineer, member of the Paris Academy of Sciences, died on March 8, aged sixty-nine years.

THE death is announced of Professor William H. Lennon, for forty-two years head of the department of science in the Brockport State Normal School, New York.

PHI LAMBDA UPSILON, the honorary chemical society, will hold its biennial convention at Milwaukee, Wis., March 24 and 25, just preceding the meeting of the American Chemical Society. The headquarters for the convention will be the Hotel Pfister.

THE regents of the University of Wisconsin have voted to extend an invitation to the Association of American Agricultural Colleges and Experiment Stations to hold a four-week graduate school in agriculture and home economics at the university, in July, 1914.

THE German Association of Engineers is making preparations for the reception of the American Society of Mechanical Engineers, which will hold its annual meeting this year in Leipzig. The Americans will arrive at Hamburg on June 19. Following the meeting they will make a fortnight's tour of Germany.

THE twenty-second session of the Marine Biological Laboratory of Stanford University, will begin Tuesday, May 27, 1913. The regular course of intruction will continue six weeks, closing July 8. Investigators and students working without instruction may make arrangements to continue their work through the summer. The laboratory, which is at Pacific Grove, will be under the general supervision of Professor F. M. McFarland, instructor in charge.

A CONFERENCE on the Conservation of Human Life will be held at Reed College, Portland, Oregon, on May 9, 10 and 11, 1913. There will be lectures, discussions, exhibits, moving pictures, out-of-door games and meetings of societies. All organizations and individuals devoted to human welfare are invited to take part in the conference. Fifteen rooms are available for the exhibits and fifteen rooms for meetings of such organizations. Three assembly rooms are equipped for stereopticon exhibitions. The following topics suggest the

scope of the conference: Organized efforts to abolish war, venereal diseases and child labor; to obtain pure foods, to prevent tuberculosis, to promote temperance, to improve conditions of labor, to safeguard men at sea and on railroads, to improve country life conditions, to better the living conditions of prisoners, juvenile offenders and other defectives, to prevent contagion, to curb occupational diseases, to solve the housing problems of cities, and the health problems of immigration, to promote school hygiene, playgrounds and recreation centers.

The coroner of Cook County, with headquarters in Chicago, is about to establish a chemical laboratory, primarily for toxicological chemistry. The salary of the chemist in charge will be $2,500 per annum, and there will be one assistant. The work will be directed by an advisory committee consisting of Hon. Harry Olson, chief justice, Municipal Courts of Chicago; Professor John H. Long, professor of chemistry, Northwestern University Medical School; John A. Wesener, M.D., Columbus Memorial Laboratory; Ludvig Hektoen, M.D., director, Memorial Institute for Infectious Diseases; Professor Walter S. Harnes, professor of chemistry and toxicology in the University of Chicago and Rush Medical College. Applications may be sent to Peter M. Hoffman, coroner, Room 500, County Building, Chicago, Illinois.

The Field Museum of Natural History announces its thirty-eighth Free Lecture Course as follows:

March 1—"A Look into South America," Professor Rollin D. Salisbury, the University of Chicago.

March 8—"Fossil Collecting," Mr. A. W. Slocom, assistant curator, Division of Invertebrate Paleontology.

March 15—"Cultural and Somatic Evidences of Man's Antiquity," Professor George Grant MacCurdy, Yale University.

March 22—"Spain: Country and People," Mr. Arthur Stanley Riggs, New York.

March 29—"Newfoundland," Professor M. L. Fernald, Harvard University.

April 5—"Wild Flowers of the Chicago Region," Dr. C. F. Millspaugh, curator, Department of Botany.

April 12—"Crossing the Andes of Northern Peru," Mr. W. H. Osgood, assistant curator of mammalogy and ornithology.

April 19—"Logging California Redwoods," Mr. Huron H. Smith, assistant curator, Division of Dendrology.

April 26—"Religious and Artistic Thought in China," Dr. Berthold Laufer, associate curator of Asiatic ethnology.

Lincoln Hall at the University of Illinois was formally dedicated "to the study of the humanities, in memory of Abraham Lincoln, and in the name of the people of Illinois" on Lincoln's birthday, February 12. Representatives from many American educational institutions were present. Addresses on the importance to the commonwealth of adequate provisions for the study of the humanities were made by Professor Bliss Perry, of Harvard University; Dean Frederick J. C. Woodbridge, professor of philosophy at Columbia University, and by Dr. Albert Shaw, editor of the *Review of Reviews*. Bishop Wm. F. McDowell, of Chicago, conducted the ceremony of dedication, and addresses were made by the governor of the state, the president of the board of trustees, the state architect and the president of the university. Dr. Hugo Black, of Union Seminary, New York, spoke on "How Lincoln Appeared to a Scotchman." The sum of two hundred and fifty thousand dollars was appropriated at the session of the Illinois legislature beginning in January, 1909, the hundredth anniversary of Lincoln's birth, for a building to be dedicated to the study of humanities. It was decided to make this building a memorial to Abraham Lincoln, the first citizen of Illinois to be elected president of the United States, the signer of the bill which made the state university possible and the consistent and persevering friend of higher education in state and nation. The scheme of decoration includes a series of

memorial panels, tablets, medallions, inscriptions, etc., relating to Lincoln and his times, so that students and professors at work in this building, or even passing along the walks about it, should be in daily and hourly remembrance of what this man and his coworkers did for the American people. Quarters are provided on the first floor for the classics and for the philosophical group or department; on the second floor, for English and modern languages; and on the third floor, for the social science group, comprising history, economics, politics and sociology. The north and south wings of the fourth floor are set apart for two museums. The museum of classical archeology and art comprises collections designed to show especially the influence on our American life of the fine arts of the Greeks and Romans, particularly sculpture and other forms of antiquities, by means of casts, photographs and original articles. The second museum, the museum of European culture, occupies the north wing of the building and contains much illustrative material. The museum of classic art was opened on November 8. Professor George Henry Chase, of Harvard University, delivered the dedicatory address. The museum of European culture was opened February 6, at which time Professor Kuno Franke, of Harvard University, delivered two addresses.

UNIVERSITY AND EDUCATIONAL NEWS

JAPANESE graduates of Harvard University have subscribed a fund of $20,000 as the foundation for a lectureship in the department of philosophy to provide for the teaching of Japanese and other Oriental systems of philosophy.

ON March 6, the University of Illinois opened a medical college in Chicago. The property formerly belonging to the College of Physicians was definitely presented by the alumni to the university. It is valued at $500,000 with an indebtedness of $245,000. Twice the state legislature by a large majority has appropriated money for a medical school in connection with the university. The first time the bill was vetoed by the governor because of lack of funds, the second time the bill was thrown out on a technicality. At the opening exercises addresses were given by Dr. Frank Billings, dean of Rush Medical College, by Dr. A. R. Edwards, dean of Northwestern University Medical School, by Dr. Arthur Dean Bevan, chairman of council on Medical Education, American Medical Association; by President E. J. James, of the University of Illinois; by Dean W. E. Quine and others.

THE plans for transforming the scientific institutes at Frankfort-on-Main into a university have now been sanctioned by the Prussian ministry of public instruction. The capital subscribed is nearly $2,000,000.

DR. A. R. FORSYTH, F.R.S., has been appointed chief professor of mathematics at the Imperial College of Science and Technology, London.

MR. AUGUSTINE HENRY, M.A., reader in forestry at Cambridge, has been appointed professor of forestry in the Royal College of Science for Ireland. The chair of forestry at the college has but recently been established.

MR. ROBERT B. BOURDILLON, lecturer in chemistry at Balliol College, Oxford, has been elected to a fellowship in chemistry on the teaching staff of University College.

AT Sheffield University Miss Sophia M. V. Witts, M.D. (London), has been appointed to the newly-instituted post of "lady tutor in anatomy."

THE following appointments have been made in the department of public health at King's College, London: Dr. E. W. Routley, medical officer of health, Aldershot, to be lecturer in sanitary law and administration; Colonel W. G. King, late sanitary commissioner in the Madras Presidency, to be lecturer in applied hygiene in the tropics; Dr. W. F. Roach, to be lecturer on school hygiene for medical officers.

DISCUSSION AND CORRESPONDENCE

THE YELLOWSTONE

To the Editor of Science: In a recent lecture before the students of Lehigh University describing a camping trip through the Wind River Mountains and through the Yellowstone Park during the summer of 1911, I exhibited a working model of a geyser which erupted about forty times per hour, and a working model of the curious Handkerchief Pool which is located in the Upper Geyser Basin about a mile west and north of Old Faithful Inn. Perhaps some of the readers of Science may be interested in the model of the Handkerchief Pool and the explanation of its action.

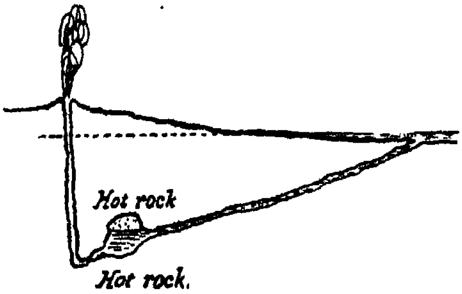


Fig. 1.

The eruptive action of a geyser is probably due, as Bunsen suggested, to the heating of the water at the bottom of a deep hole to a temperature much above 100° C., and the consequent violent boiling of this over-heated water when the pressure is suddenly lowered by the blowing out of the water in the upper part of the hole. A small working model of the geyser can not conveniently be made on this principle. The principle of operation of the model geyser I used in my lecture is shown in Fig. 1, and the actual apparatus is shown in Fig. 2.

The principle of operation of the Handkerchief Pool is shown in Fig. 3. Hot water is pushed in a sudden pulse through a channel and through the small throat TT into a shallow pool PP, and the condensation of the driving steam causes a sudden backward suction through the throat. This action is repeated several times per minute, and the hot water in the shallow pool being cooled, flows downwards at the edges of the pool and towards the throat as indicated by the arrows. Placing the handkerchief at the edge of this

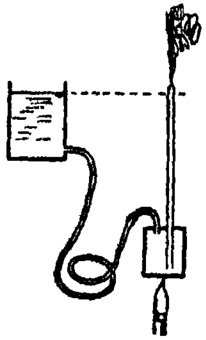


Fig. 2.

pool it is carried towards the throat by the downward flow of cool water, and when it comes near the throat it is suddenly sucked out of sight into the chamber C. The impres-

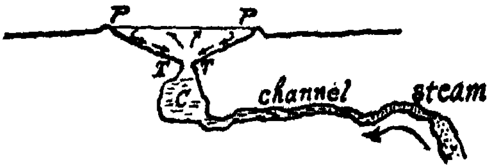


Fig. 3.

sion is that one will never recover his handkerchief, but in the course of about half a minute the handkerchief is thrown violently out of C by an upward surge of hot water. If the handkerchief is left in the pool this behavior is repeated over and over again.

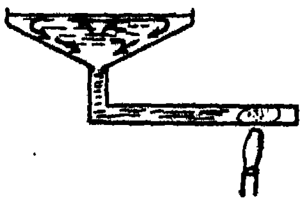


Fig. 4. Working Model of Handkerchief Pool.

In all probability the numerous small hot springs in the Geyser Basin and perhaps also at Mammoth Hot Springs come from jets of

steam which are condensed near the surface of the rock and the condensed water collects in small pools from which it flows in a small stream. The hot springs at the lower levels may be genuine streams of water flowing from great depths, but it is inconceivable that they should originate in one connected body or stream of water.

Tourists who camp in the Park are called "sagebrushers," and if you wish to excite the indignation of a "sagebrusher" talk to him about Yellowstone Park bears! One or two bears feeding at each hotel garbage dump would be sufficient for tourists; but at present bears congregate at the various hotel garbage dumps to the number of fifteen or twenty at a time, and the cleaning out of sagebrushers' camps by marauding bears is a nightly occurrence. The one all-absorbing topic of conversation among sagebrushers is marauding bears; and it is by no means a joke, for three or four sagebrushers are killed nearly every summer in attempting to drive bears out of their camps! The Yellowstone Park bears are an unmitigated and intolerable nuisance, and nine tenths of them should be killed at once. The only alternative is for the Park authorities to establish a vigilant all-night watch around every camping ground.

One of the points of interest at Mammoth Hot Springs is a grotto, a cavity in the hot-springs formation, and tourists are taken into this grotto in parties of twenty or thirty at a time. Only one hundred yards or so from the grotto is an opening through which carbon dioxide issues, filling a small depression at the bottom of which two or three dead birds are usually seen. If a crevice should be opened up from the grotto to any of the old hot-water channels, the grotto would in all probability be filled with carbon dioxide, and the next party of tourists would be left at the bottom of the grotto like the birds in the little valley near by. It would be wise on the part of the park management to provide for a test of the air of the grotto every morning during the tourist season. If this is not done a disaster is likely to occur at any time.

At Mammoth Hot Springs Hotel I wished to purchase a number of large colored views and I naturally went to the "official photographer of the park." The next day, however, I found a better grade of pictures for sale at an outside place and at a cheaper price, and to my disgust I found that the colored views I had purchased from the official photographer were of foreign manufacture, whereas the cheaper and better ones which were sold by the unofficial photographer were of American manufacture! Surely the position of official photographer should be done away with in the Yellowstone Park. Very certainly it is not right for the public to be led by the term "official photographer" to purchase foreign-made colored views which are more expensive than American-made views and at the same time distinctly inferior.

Any one who has traveled through the region to the south and east of the Yellowstone Park must realize what a splendid game preserve we could have if the Yellowstone Park were extended to the east so as to include the Absaroka Mountains and to the south so as to include Jackson's Hole and Teton Mountains and Gros Ventre Mountains. The private holdings of land in Jackson's Hole could be purchased for a very moderate sum and the entire surrounding mountain region is already included in the National Forest Reserves. It would be a very easy matter for the national government to greatly extend the boundaries of the Yellowstone Park and create what would be perhaps the most magnificent asylum for wild animals in the whole world.

W. S. FRANKLIN

ALLEGHANY VALLEY EROSION

TO THE EDITOR OF SCIENCE: In the recent issue of the *Bulletin* of the Geological Society of America, Vol. XXIII., p. 295, is the paper of G. F. Wright on "Postglacial Erosion and Oxidation." In the summary of the discussion which followed, the reporter states that Mr. Leverett offered as disproof of the conclusions of Professor Wright the "great erosion in the upper Alleghany region which occurred between the deposition of the old drift and of the young or Wisconsin drift."

Here is a general statement that there is an "old" and a "young" drift in the "upper Alleghany region," and that a "great erosion" occurred between their deposition. The generality of the statement would lead one to infer that the erosion was general throughout the region, and that this fact was generally received, as well as that there was such a distinction between the "old" and "young" drifts that they could be readily differentiated everywhere by physical characteristics.

In discussing this statement we must first ascertain what Mr. Leverett considers "the upper Alleghany region," as the river is a long one. Happily we have in the map compiled by Mr. Alden for the Geological Survey a very plain demarkation of areas variously estimated by Mr. Leverett. In the above discussion he uses the term "old" drift, referring to the first or Kansan advance. Combining this statement with the areas of the map we arrive at the conclusion that the uppermost portions of the Alleghany region to which he can possibly refer begin in the immediate vicinity of Warren, Pennsylvania, which is about 100 miles from the source of the river, as above that place the river is marked as flowing through areas not reached by Kansan ice. The terms Kansan and Wisconsin are used to define alleged earlier and later phases of glaciation separated by a long interval. We will, therefore, discuss the conditions of this system from Warren southward; but as there is no method of estimating where Mr. Leverett's term "upper" ends, we will continue our discussion to and below Parker, which is half way between Warren and Pittsburgh.

After Lewis and Wright published the volume of the Second Geological Survey of Pennsylvania delimiting the "terminal moraine," Carll, in his report of the Warren region, called attention about thirty-five years ago to the preglacial channel of the Conewango now deeply buried throughout in drift which rose near Kane and flowed westward through Sheffield, Clarendon, Stoneham and Glade, between which place and Warren it crossed the present channel of the Alleghany and flowed north into the St. Lawrence drainage system. On the northern bank of this stream and over 100 feet above its present level is a remnant of Mr. Leverett's "old drift." Between the time of its deposition and the excavation of the wide valley to present level he imagines that a long period has elapsed, and this excavation is his "great erosion." At Clarendon is more of his "old drift," also at Franklin; also at Parker. Bradford, being above Warren, is in the unglaciated area. The distances apart of these places are: Bradford to Warren (along the valley lines), 60 miles; Warren to Franklin, 60 miles; Franklin to Parker, 35 miles; Kittanning is about 25 miles below Parker. These distances enable us to employ the rule which obtains in geology as well as geometry, that when a number of points in a line or plane sufficiently distant from one another have been referred to a given datum plane, the portion of the line or plane included between those points has also been referred to the same plane. The datum plane in this case is the present drainage level of the Alleghany, and to it we will refer both the underlying rock bottom and the "old drift" of Mr. Leverett.

Our data for reference exist abundantly, as the region had been pierced from surface to great depths by tens of thousands of oil wells whose sections have been recorded, and many have been published. These wells are found in numbers on the "old drift," the "young drift," the mountain tops, the swamps and the river beds, and where rock was not near the surface a pipe was driven through the loose deposits till rock was struck. These "drive-pipe" records show the materials passed through, and form a valuable and conclusive array of facts beyond the possibility of cavil or argument.

The problem for discussion is the probable form and sequence of deposits over a region deeply flooded by an approaching but still distant glacier which forced the waters over a still more distant col which was gradually degraded. Every prospecter and ore-dresser is well acquainted with the classifying and

sorting powers of streams of varying velocities, and nothing could more plainly show the distance of the glacier and the stagnation of the water than the varying thicknesses of clean sticky clay which universally lie against the rock floor of the region. Where bays to one side of the line of current offered especially still water its thickness runs up to 100 feet. Even on the hillside at Warren near the "old drift" and not far above present water level the writer has found it and taken fragments of wood therefrom. This presence of the broken pieces of the old forest in the clay is proof of a first invasion of the region, and at Bradford, Clarendon, Stoneham and elsewhere outside of the area of discussion the heaps of accumulated logs were so well preserved as to make the driving of the pipe to bed rock a most difficult operation. Even as far down the river as Kittanning this clay is so abundant as to furnish material for the manufacture of china. Above this the sequence of deposits is a fine quicksand resembling a friable clay; a coarser quicksand; sands, and, finally, gravels. Where there was continuous current action the lighter varieties are generally absent, and where it swept along one side of a valley with torrential force even the gravels are absent on that side, as at Warren, Franklin, Brandon, Kennerdell and numerous other places not noted in the many discussions of this region. At Bradford, Stoneham and Clarendon we have the whole series as it was laid down, as shown by the thousand wells of Bradford, the hundreds at Stoneham, and the 1,300 or more of the South Pennsylvania Company about Clarendon.

Regarding the alleged "old gravels" which are supposed to have been laid down in a river bed whose bottom was several hundred feet above present water-level, we find that they vary in level A.T. 100 feet or more within a few miles and around the shoulders of the same hill. Streams never run up hill and so there was no stream deposition at such places.

Coming from generalities to specific localities we find at Bradford, outside of the so-called Kansan area, that the valley for miles has a nearly flat surface, and the rock floor averages 200 feet below it. Taking the Clarendon-Stoneham-Glade-Warren rock floor of Carll's preglacial stream we find the drive pipes at the first place will run from 200 to 310 feet. The last was located on and ran through Mr. Leverett's "old drift." At Stoneham the average is 200 to 232 feet: at Glade, 100 feet: at Warren, and again on the "old drift" are several wells which place the rock floor on a slope running from present water level to fifty feet below it. The averages of the four localities above given show that the floor dips from Clarendon to Warren and will average 1,200 A.T., or below present water-level. This being the fact, the "old drift" patches are shown to be the youngest of a regular series, and as the rock floor level was determined before deposition began, there has been here no "great erosion." For 60 miles of the valley we can say "no erosion."

At Franklin we find rusty gravel on the hillside north of French Creek. The new water works enabled the writer to inspect a deep trench for the city mains which ran from just above water-level to several hundred feet up the mountain, where the reservoir was being built. As the trench went down to soil rotting in place there was a chance to see the soil line and to note that the sediments were washes parallel thereto, and carrying the same amount and kinds of foreign rocks throughout all elevations exposed. Here also the "old drift" lay on top of the wash, and there was no "erosion."

Parker was made much of, as here was an alleged "abandoned loop" of a mythical Alleghany of Kansan times. The writer showed, more than a dozen years ago in SCIENCE, that the wide difference in elevation, material and dip of the deposits precluded their being laid down by a stream, and this was proved by the usual oil well not very far from the Alleghany which went down through the "old drift" to below the present water level.

We have now performed our task, the reference of the "old drift" at Warren, Clarendon, Franklin and Parker to the present water level, and in all these places it lies over the old bottom as the uppermost of a regular

series laid thereon, showing conclusively that the bottom was leveled preglacially and that there has been no "erosion."

In view of these facts, which anybody can check, it is germane to the subject to ask Mr. Leverett to kindly be specific and state exactly where this "great erosion" occurred over the "upper Alleghany region."

Edward H. Williams, Jr.

ACADEMIC FREEDOM

To the Editor of Science: The dismissal of Professor Willard C. Fisher from the chair of political and social science at Wesleyan University, which has now been made formal and definitive by the acquiescence of the trustees in the action of the president, is an occurrence that shows the need of constant effort and discussion in order to maintain the right of freedom of speech and of teaching. The correspondence between President Shanklin and Professor Fisher, as published in a recent number of Science (February 14), is on its face sufficient evidence that a teacher who had served the institution for twenty years was summarily removed on grounds that are absolutely trivial and puerile. From various sources which seem reliable the report comes that Professor Fisher's address at Hartford was not the cause of his dismissal, but that the real ground is to be found in the objection felt by the president and some of the trustees of the college to his political and social views. If this is so, it only emphasizes the fact that there has been a serious infringement of the principle of academic freedom. The matter is too serious to be allowed to drop: it seems desirable that there should be protests from universities, learned societies and individuals so numerous as to arouse public opinion and render any similar occurrence impossible in the future. Physical science has fortunately no longer to fear any direct interference from outside authority. It is a long time since Galileo; and even the doctrine of evolution now calls out no protest from any quarter. But the representatives of these sciences will not fail to recognize that their own cause is bound up with that of the economists and social philosophers who now furnish the chief grounds of offence to the "interests." For freedom of speech and of research can not be limited to certain subjects: science can not exist half slave and half free. I conclude by quoting an extract from an address of President Schurman as reported in the *Cornell Sun* for September 24, 1897, which seems to me a fine statement of principles of which we should never lose sight.

If it is asserted that the business of the college or university is to teach that which the average man may believe, or that which is acceptable to the university, or that which the board of trustees may assert as the truth, the answer must always be that such a course contravenes the very principle on which the university was founded, and however true it may be that the majority must rule in the body politic, the motto of the university must be, one man with God's truth is a majority. There is also a second principle involved in what has been said if all this be true. It is perfectly clear that every teacher must be free to carry out his inquiries and to announce and proclaim if he wishes what he has observed, or in dealing with the individual student the teacher must be free to present all phases of the question as they occur to him—otherwise he has missed his great vocation as a teacher.

Money is needed by universities. I know it well. I know that our board of trustees is constantly wrestling with the problem of how to make both ends meet, how to meet the legitimate demands of the heads of departments and colleges, yet if money is to be got for the institution by the suppression of the truth, by setting any limitation whatever upon the freedom of the teachers to inquire or to announce the results of their inquiries, better a thousand times that the institution should go out of existence. The end of a university is truth and the promotion of truth. Money may be a means to that end, and as a means it may kindle a great light; as an end it can only produce total darkness. Hence any attempt to set limitations upon the independence of the teaching staff must be resisted, must be unwarranted. We need for the advance of civilization the striking out of new ideas or the application of old ideas to new fields. Where are such ideas to be urged, if the business of the university is to teach what is acceptable to the community? All science would be impossible on this theory.

It was perhaps more than a coincidence that this address was delivered soon after the resignation from Brown University of President E. Benjamin Andrews.

J. E. CREIGHTON

CORNELL UNIVERSITY.

SCIENTIFIC BOOKS

The British Tunicata. An Unfinished Monograph by the late JOSHUA ALDER and the late ALBANY HANCOCK, F.L.S. Edited by JOHN HOPKINSON, F.L.S., F.G.S., etc., Secretary of the Ray Society, with a history of the work by the Reverend A. M. NORMAN, M.A., D.C.L., F.R.S., etc. Volume I., 146 pp., 20 pls., 1905; Volume II., 162 pp., 50 pls., 1907; Volume III., 90 pp., 66 pls., 1912. The Ray Society.

With the appearance during the last year of a third volume of Alder and Hancock's researches on British ascidians all that is to be printed of this magnificent work is now available to students. The earlier volumes have been duly noticed by reviewers as they were distributed; but for the sake of completeness it will not be amiss to speak of all three volumes together.

The task of selecting and preparing the manuscript and illustrations must have been both perplexing and laborious, for we are told by Canon Norman in his history of the work which introduces the first volume, that the drawings, particularly those by Hancock, are very numerous and in many stages of completion. The bracketed words, sentences and paragraphs scattered all through the text testify to the extensive and painstaking work performed by Mr. Hopkinson.

Very wisely not much has been added to or subtracted from the work as it left the hands of the authors. The diagnoses of species of the compound ascidians have received more editorial modifications than have these of the simple ones. In a few instances species and genera have been included which did not appear as such in the manuscript, but only where the notes and sketches warranted.

The part played by Canon Norman in bringing the work to the light of day was undoubtedly done under the stimulus of personal devotion and direct scientific interest, his friendship for and association with the authors having been intimate and of long standing, and he contributed much, particularly in the way of specimens, to the substance of the monograph. Mr. Hopkinson's rôle seems to have been solely that of an official and a man of science, and what he has done is a fine testimonial to his ability in this way.

Volume I. contains, as mentioned above, a review of the origin and vicissitudes of the work, by Canon Norman; an introduction by the authors; a reprint of Hancock's "On the Anatomy and Physiology of the Tunicata" originally published in the *Journal of the Linnean Society of London* in 1867; and the systematic treatment of all the species of the genus *Ascidia*. Volume II. opens with a life of Alder by Norman, and of Hancock by Embleton, and deals with the remaining genera, *Ciona* and *Corella*, of the family Ascidiadæ, and the families Molgulidæ, Cynthiadæ, and Clavelinidæ. Volume III. treats of the "Aggregatæ," of which three families, Polyclinidæ, Didemnidæ and Botryllidæ, are recognized, and ends with a supplement by Mr. Hopkinson containing "Additional References and Localities"; a "List of the Species described in the Monograph, with the Genera under which they would probably now be placed," and a "General Index."

There can be no question about the value of this monograph, even though it represents the state of knowledge of ascidians as it was forty years ago, and makes no pretense of concerning itself with other than British species. Its chief utility will naturally be as a handbook for British students and other persons who frequent the shores of the British islands. The great number and excellence of the illustrations, particularly those of habitus of the kinds, "forms," varieties and species, mostly by Alder, will make it specially useful in this way. Nearly all the figures, even the anatomical ones from Hancock's faithful brush, are in color. The authors evidently devoted much less time to the compound than to the simple species; and for illustrating

these the editor has largely supplemented the original drawings from figures by Savigny and Milne Edwards. But the usefulness of the book will be by no means restricted to students who are countrymen of the authors. It will undoubtedly take a conspicuous place in the working library of specialists in the group wherever located, as it already has in that of the reviewer.

Divers reflections are induced by reading the divers things said in these volumes by divers persons. The brief, straightforward account by Canon Norman in Volume I. of how the monograph came to be undertaken relates that Alder was requested by the keeper of the zoological department of the British Museum to prepare a "Catalogue of British Tunicata" as one of the series of catalogues then being issued by the Museum; that Alder at once took up the task and pushed it to the exclusion of everything else; and that after several years' work when he reported the manuscript ready to be turned in he was informed by the keeper (with the deepest regret) that somebody had withdrawn the grant for publishing the catalogues, and that consequently his work could not be published. In the absence of information to the contrary this looks like a flagrant breach of contract on the part of the Museum, and reminds one of the frequent charge that institutions and governments hold themselves less bound by contracts than individuals are supposed to be held. If this be so the fact can only mean that communities in which it is true are still in an immature stage of advancement in civilization, so that as time goes on and with it progress it will be impossible for such cases of broken faith to occur.

The extent to which embryological knowledge may modify interpretations based solely on anatomical knowledge could hardly be more strikingly illustrated than by Hancock's ideas about the homologies of tunicate organs. He knew almost as much as we of to-day know about the gross structure of full-grown ascidians, yet he considered the close kindred of the group with the polyzoa to be fully established! The proposal made by several zoologists to separate the ascidians from the mollusca he looked upon with great disfavor, and his efforts to prove the resemblance between the respiratory apparatus of an ascidian and that of a bivalve mollusc seem curious enough to us now. Of course he was familiar with the tadpole stage of the individual ascidian, though he thought it a secondary acquirement. But it is not alone with reference to these broad generalizations as to group affinities and classification that discoveries in development have changed morphological ideas. There is hardly a page of Hancock's essay that does not contain some interpretation, expressed or implied, which does not accord with present views. Kowalevsky's epochal "Entwickelungsgeschichte der einfachen Ascidien" was published in 1866, and although Hancock's "On the Anatomy and Physiology of the Tunicata" did not appear until the next year, there is no indication that the English comparative anatomists had read the memoir of the Russian embryologist.

In an addendum to the biographies of the authors which introduce the second volume, Canon Norman remarks that Alder and Hancock were "naturalists of a by-gone time." "With only very moderate advantages," he says, "as regards early education, they progressed greatly in knowledge by private study as years went by. An intense love of nature absorbed them, and they realized that everything else must be sacrificed to allow them to find out nature's secrets." When one recalls that these were only two among a considerable number of Britishers of that period who, largely self-trained, passed all or a great part of their lives in unremitting toil as investigators of nature, and did this without compensation or institutional aid, he can but be mindful how unqualifiedly true is Norman's remark about a by-gone age. Undoubtedly the refinements of method in nearly all departments of research, necessitated by the advancements that have been made, account in large measure for the almost entire disappearance of this type of scientific man. The professionalizing and institutionalizing of science in our day as compared with former days have

been, inevitably, both result and cause of the wonderful progress that has gone on. Surely there is neither possibility nor desire to return to the conditions of a half-century ago. But a certain quality or attitude of mind essential, according to the reviewer's notion, to the best achievements has been lost since the former days. Reference may be made to what some astronomer, Professor Hale I believe, has extolled as the amateur spirit in science: a spontaneous, perennial curiosity; a wide-awakeness of perception; an openness of mind; and a nimbleness of imagination, as touching all sorts of objects and processes and incidents in one's surroundings. The belief prevails widely among biologists of the present day that this sort of thing necessarily begets superficiality—that it is inimical to that profundity demanded by the deep, ultimate problems which constitute the soul of science. The belief is, however, not justified by either the history of scientific discovery, or our modern knowledge of the constitution and workings of the human mind. The "complex" of recent psychology is a "system of connected ideas with a strong emotional tone"; and specialization may go so far in both differentiation and intensification as to tend to reduce the system of ideas to one idea, and to destroy the "emotional tone."

Such works as the one now before us, taken in their entirety, ought to serve the two-fold end of helping on knowledge in a restricted field of zoology, and of restoring to biological research something of the amateur spirit.

WM. E. RITTER

List of North American Land Mammals in the United States National Museum, 1911. By GERRIT S. MILLER, JR., Curator, Division of Mammals, United States National Museum. Bulletin 79, United States National Museum. Washington, Government Printing Office. 1912. 8vo. Pp. xiv + 455.

This volume is a most welcome contribution to mammalogical literature, giving, as it does, in systematic sequence, the names of the species and subspecies of all North American land mammals currently recognized down to the end of the year 1911, and a large part of those described during 1912. "North America," for the purpose of the list, comprises "the entire continent from Panama northward, together with Greenland and the Greater and Lesser Antilles." It consequently includes the Island of Trinidad, which is, faunally and geographically, really South American. According to the author's tabular summary, the number of "forms" included in the list is 2,138, of which 1,955 are represented in the United States National Museum, leaving only 183 as unrepresented. The types of about one half of the total number of forms are in the National Museum.

The plan of the list is about as follows: The classification, or "sequence of groups is, in its main features, that adopted by Osborn in his 'Age of Mammals,' 1910, though the arrangement of the families and genera has been revised to make it as consistently as possible in harmony with that of the higher groups." References are given to the place of first publication of all generic, specific and subspecific names, and types are designated for the genera. In the case of species and subspecies, reference is usually made to the first use of the binomial or trinomial here adopted, and to True's list of 1885. "The type locality of each form is stated with all possible exactitude; and in revised genera the ranges are given as printed by the author," references to such revisions being given in footnotes.

The list includes: (1) species and subspecies that "had not been questioned in some recent work of definite monographic character" prior to the end of the year 1911; (2) forms belonging to groups which have not been treated in a monographic paper; and in cases where differences of opinion regarding their status have developed, "references are given to the conflicting views," at least in most cases. The utility of this work to investigators is further enhanced by an asterisk prefixed to the names of forms contained in the National Museum, and also a dagger in case the museum also has the type. The author has of

course expressed his preferences in deciding disputed questions of nomenclature, of which a few might well be referred to the International Zoological Congress for arbitration.

As already stated, the number of species and subspecies of North American land mammals is in round numbers about 2,150, without including a considerable number described late in the year 1912. The first enumeration comparable in geographic area with Mr. Miller's was published by True[1] in 1885, numbering 365 species and subspecies. This number, according to Miller and Rehn,[2] had increased by the end of the year 1904 to 1,450. Elliot, in 1905, in his "Check List of the Mammals of the Continent of North America, the West Indies and the Neighboring Seas,"[3] included 1,940 forms of land mammals, he listing a considerable number that have since, through the work of monographers, passed into synonymy. Doubtless when other groups are subjected to this ordeal many listed in the present check list will also lapse, so that the number now fairly entitled to recognition may be estimated at about 2,000. Probably many valid additions are yet to be made from parts of Central America now very imperfectly known.

The task of preparing the present list could hardly have fallen to more competent hands, and mammalogists owe a debt of gratitude to its author for the great aid it will be to them in their work. It is to be regretted, however, that so unusual and confusing a system of classification has been adopted, the scheme being based on specialization, the sequence of the higher groups being determined by the amount of their departure in structure from the most "primitive" or "generalized" mammalian type, and not on affinity or genetic relationship. The arrangement therefore will be very confusing and unprofitable to nine tenths of the users of Mr. Miller's book, who have been led to suppose that the purpose of a system of classification designed for general use was to indicate, so far as possible in a linear sequence, the affinities of the animals classified. The classification here adopted may serve the purpose for which it was intended—an expression of the relative degree of specialization among the ordinal groups of mammals; but it is rather startling to the uninitiated to find the two ends of the series represented, respectively, by the Monotremes and the Cetacea, and the Primates flanked on one side by the Edentates and on the other by the Artiodactyls: In other words, to find an otherwise admirable check list of the mammals of a continent arranged in conformity to a scheme of classification which ignores genetic relationships and therefore is out of touch with current faunistic and systematic work on recent mammals.

J. A. A.

[1] True, F. W., "A Provisional List of the Mammals of North and Central America and the West Indian Islands," *Proc. U. S. Nat. Mus.*, Vol. 7, 1884, pp. 587–611 (appendix, 1885).

[2] "Systematic Results of the Study of North American Land Mammals to the Close of the Year 1900," *Proc. Boston Soc. Nat. Hist.*, Vol. 30, pp. 1–352, December, 1901.

[3] Field Columbian Museum, Zool. Ser., VI., 1905.

General Chemistry of the Enzymes. By Hans Euler, Professor of Chemistry in the University of Stockholm. Translated from the German by Thomas H. Pope. New York, John Wiley and Sons. Pp. 323.

The chemical changes which are taking place continually in plants and animals fall, for the most part, under that branch of science which is called organic chemistry. It is characteristic of organic reactions that they proceed slowly, though their progress can often be hastened by the addition of small amounts of particular substances, the so-called catalysts. This property of hastening the speed of organic reactions by supplying an appropriate catalyst is wonderfully developed in living organisms, because the element of time is all-important to them. The catalysts which occur in organisms are given the general name of enzymes. In many cases they can be readily separated from the cells of the organism and they are accordingly considered to be *organic chemicals, probably of* complex composition, but without organized or cell structure. Up to the present time no one has succeeded in crystallizing or vaporis-

ing an enzyme and therefore such a thing as a pure enzyme is now unknown. For this reason the chemical analyses of dried "enzyme preparations" signify little, because it is impossible to know what portion of the preparation is enzyme and what is impurity. Pending the discovery of some method for crystallizing enzymes this branch of their study is practically at a standstill. On the other hand, the study of the mode of action of enzymes and the influence of temperature, acids, etc., upon their catalyzing power is advancing rapidly and it is with this subject that Professor Euler's treatise deals. To quote from the preface, he "has attempted to review the more important facts of enzymology from a general standpoint and to fit them, as far as is possible, into their proper places in the fabric of general and physical chemistry." This book is the first in which an attempt has been made to describe this branch of science from the standpoint of theoretical chemistry and special credit is due Professor Euler for his excellent treatment of the subject. The following chapter titles may serve to give an idea of the contents of the book: Special chemistry of the enzymes, their physical properties, their activators and poisons, the chemical dynamics of enzyme reactions, the influence of temperature and radiation on enzymic reactions, the chemical statics of enzyme reactions, enzymic syntheses and the specificity of enzyme action. The work of translation by Mr. Pope has been very carefully done. The publishers are also to be commended for the quality of the printing and binding.

C. S. HUDSON

SPECIAL ARTICLES

MITOCHONDRIA IN ASCARIS SEX-CELLS

DURING the course of preparation of a thesis for the Doctor's degree at the University of Pennsylvania, entitled "The Spermatogenesis of *Ascaris megalocephala* with special reference to the two Cytoplasmic Inclusions, the *Refractive Body* and the '*Mitochondria*'; their *Origin, Nature* and *Rôle* in Fertilization," the following observations were made:

The refractive body arises, as Marcus (1906), Mayer (1908) and Romieu (1911) point out, by the fusion of the refringent vesicles while still in the vas—probably just before copulation occurs. The refringent vesicles arise from minute granules scattered here and there throughout the cytoplasm in the early growth period of the spermatocyte. These granules stain blue after the material is fixed in Benda's modification of Flemming's strong solution and stained in Benda's "Krystal Violet." This reaction is characteristic of true mitochondria. Granules staining exactly like these are found constantly in the nucleus of the spermatogonium, *and these actually pass through the nuclear membrane* into the cytoplasm of the spermatocyte. This blue staining material, or true mitochondria, is apparently derived directly from the chromatin because in several cases chromosomes in the spermatogonial nuclei were cut, showing the red-brown interior (the typical reaction to Benda's stain for chromatin) covered by a blue layer. Thus the refractive body is ultimately derived from the chromatin of the spermatogonium, and it is formed by true mitochondria; these are not only nuclear in origin, they are derivatives of the karyosome. They should, therefore, be called *karyochondria* to distinguish them clearly from the *plastochondria* (Meves) which are derived from the plasmosome of the spermatogonial nucleus.

The refractive body has but one function—namely, to feed the spermatozoon on its long and exhausting journey (by pseudopodial creeping) to the "entrance region" at the proximal end of the uterus. This is proven by the fact that many eggs are entered there by spermatozoa which have lost every trace of the refractive body; and further, by the fact that the decrease in size of this body takes place equally from all sides, showing that it is the surrounding layer of cytoplasm, and not the uterine epithelial cells, as all other authors maintain, which is the agent of its absorption. Not only is its axial symmetry maintained during the stages of degeneration while crowded between the epithelial cells, but also when lying amongst eggs far out in the

lumen of the uterus. So it is fed upon only by the sperm itself.

The nematodes should, therefore, be placed in Faure-Fremiet's (1910) fourth class of mitochondria-bearing sex-cells, in which these granules produce yolk.

Marcus, Mayer, Romien and Faure-Fremiet use the term mitochondria to describe minute plastin granules found in the nucleus of the spermatogonium and in both nucleus and cytoplasm of the spermatocyte. They are easily seen in the "perinuclear zone" of the spermatid and in the "crown" of the spermatozoon. But nowhere do these granules take Benda's Krystal violet stain or transform into any cell structure. Hence they have no relationship with true mitochondria. Meves recognizes their nature and origin and calls them plastochondria. Van Beneden called them "protoplasmic corpuscles"; Altmann, "microsomes"; Boveri, "archoplasm." But none of these observers attributed any importance to them as bearers of hereditary characters. Meves (1910), however, finds (like the brothers Roja, 1891) that these granules fuse with similar ones in the egg after fertilization occurs, and he believes, with only this observation as a basis for it, that these plastochondria are the bearers of paternal structural characteristics. I have carefully studied the origin and behavior of these granules throughout the spermatogenesis and find that they everywhere behave, like the plasmosome itself, as if they were waste products of the metabolic processes of the chromatin. Many of them are actually thrown off by the spermatid with the cytoplasmic lobe, not only in *Ascaris*, but in many other forms. They always take plasma stains, yellow after Benda, and red after Ehrlich-Bionde, both reactions characteristic of secretions; they are pulled about in the cell by the force of the centrosomes to form aster rays and spindle fibers of the cleavage figure; they never divide, nor grow except by fusion on actual contact; in short, they behave everywhere as inert formed products only.

I believe that the observed facts of artificial parthenogenesis, hybridization and fertilization of enucleated eggs, all argue against Meves' interpretation of the rôle of the plastochondria; while these facts and the observations of Baltzer, Tennant and others show clearly that it is the retention or elimination of chromatin (or the karyochondria) that determines the inheritance of paternal characters, segregation and dominance.

Edward E. Wildman

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION E—GEOLOGY AND GEOGRAPHY

The sixty-fourth meeting of Section E, Geology and Geography, of the American Association for the Advancement of Science, was held in the geological lecture room, main building, Case School of Applied Science, December 30, 1912, to January 2, 1913. Vice-president James E. Todd presided. The address of the retiring Vice-president, Professor B. Shimek was given on the subject, "The Significance of the Pleistocene Mollusks." Much interest was taken in the papers, which are here given with abstracts:

Esker Terraces in Ohio: G. Frederick Wright.

The Wisconsin Drift-plain in the Region about Sioux Falls, S. D. (illustrated): J. Ernest Carman.

The region considered lies to the south of Sioux Falls along the line between Lincoln and Minnehaha counties, South Dakota. Professor Todd and others have interpreted it as belonging to the Wisconsin drift-plain, being an eastward projection of the James River lobe to the Big Sioux Valley. Professor Shimek has recently decided that the region is a Kansan drift-plain and not Wisconsin. The present paper describes the characteristics of this plain north and west of Shindlar and compares it with the typical Kansan region to the north and east. The evidence, chiefly physiographic, indicates that the region is a Wisconsin drift-plain. The conclusions of the paper support, in the main, the earlier interpretation of Professor Todd.

The Pleistocene Succession in Wisconsin: Samuel Weidman.

A brief statement is given concerning present knowledge of the drift and associated surface deposits in Wisconsin, with a map showing distribution of the formations. There appear to be

five drift sheets exhibited in Wisconsin, as follows: First drift, a very old, thin drift; second drift, a very old, thick drift correlated with the Kansan of northeastern Iowa; third drift, a relatively old, thin drift, correlated with the Iowan of northeastern Iowa; fourth drift, a relatively thin, fresh drift, correlated with the early Wisconsin of northeastern Illinois; fifth drift, the Wisconsin drift. Extensive alluvial and lacustrine deposits in old valleys and lowlands, of interglacial origin between the second and third drifts. The loess deposits are of later origin than the third drift and older than the fourth.

The "Moraines" of Kansas: J. E. TODD.

Certain bouldery hills have been designated as glacial moraines by several writers on Kansas geology. This paper discusses their locations and relations to the former Kansan Ice sheet and present lines and levels of drainage and shows that they are not true moraines but river-laid deposits.

Traces of an Early Wisconsin Flood: J. E. TODD.

Attention is called to a deep silt which fills portions of the valleys of the Missouri and Kansas rivers in eastern Kansas, and which can not be correlated with the loess, because of its lower level. Because of evidences of the excavation of the valley so filled during and after the Kansas stage of the ice, it is argued that the date of the deposition of the silt was coincident with the recession of the Early Wisconsin Ice, or more definitely after the formation of the Altamont, or first marginal moraine. This lower loess or terrace silt is further provisionally correlated with terraces along the Missouri further north and its tributaries in western Iowa.

The Sangamon Interglacial Stage in Minnesota: WARREN UPHAM.

Three chains of lakes on the till area of Martin County, one of the central counties of the southern tier in Minnesota, adjoining Iowa, are ascribed to interglacial erosion of rivers flowing south, where now the courses of drainage pass eastward. The duration of this interglacial stage is estimated by Winchell, from changes of the course of the Mississippi River in and near the Twin Cities of Minneapolis and St. Paul, to have been about 15,000 years. It seems to be represented in the history of the Quaternary lakes Bonneville and Lahontan by the stage of their desiccation between their previous prolonged stage of high water and their ensuing higher but more brief rise of water; and it is correlated with the Sangamon interglacial stage between the Illinoian and Iowan stages of glaciation. Its time is estimated to have been approximately from 40,000 to 25,000 years ago.

The Relation of the Keewatin and Labrador Areas of Glaciation: WARREN UPHAM.

The Kansan and Illinoian drift sheets are regarded as mainly of contemporaneous age. They were deposited respectively by the farthest southward extensions of the Keewatin and Labrador icefields. The belt of confluence of these icefields extended from the borders of the drift northward along or near the course of the Mississippi River up to the Wisconsin driftless area, which also reaches short distances into Illinois, Iowa and Minnesota. Beyond the driftless area, these Keewatin and Labrador currents of the continental ice-sheet were confluent along a belt or line passing north-northwesterly through Minnesota to the vicinity of Winnipeg, Manitoba and onward along the axis of Lake Winnipeg. At St. Paul and Minneapolis and northward, fluctuations of the line of confluence during the Wisconsin stages of glaciation produced extensive interbedding and sometimes a confused mingling of the Keewatin and Labrador drift formations.

Types of Iron Ore in Tennessee: C. H. GORDON. Read by title.

Criteria for Distinguishing Various Sorts of Common Deposits (illustrated): A. C. TROWBRIDGE.

The Age of the Mesabi Iron-bearing Rocks of Minnesota: N. H. WINCHELL.

This paper gives a very brief summary of former opinion, and presents new evidence which goes to show that the Mesabi rocks are a part of the great Keweenawan formation.

Angular Amphitheaters of the Grand Canyon: CHARLES R. KEYES.

One of the most perfectly enigmatical features concerning the physiognomy of the Grand Canyon, in Arizona, and one to which little especial attention has been directed, is a certain regularity in the notably serrated character of the walls. Buttresses, reentrants and pyramids have a conspicuously rectangular ground-plan. So pronounced is this characteristic and so large is the scale that it is even emphasized in the latest contour-maps of the district. The angularities of the buttresses and pyramids are readily explained by the double system of master-joint structure. The deep reentrants or amphitheaters are not so easily disposed of, especially since all of the surface drainage, which is very deficient, of the general plateau

on either side of the canyon is directed away from the margin of the walls and not into the great trough. In some cases these reentrants are partially accounted for by the presence of faults trending transversely to the course of the river. In the majority of other cases the amphitheaters, great and small, appear to have originated through undercutting by differential wind action, the deflative effects being much more vigorous on the soft shales lying between the hard Carbonic limestones forming the upper wall and the hard granite floor of the inner canyon.

Geologic Significance of Enisled Relief: Charles R. Keyes.

Sharp meeting of lofty mountain and even plain, seemingly as level as the ocean strand-line, is one of the most characteristic features of desert landscapes. Foothills are also conspicuous by their absence. The very deficient rainfall of such regions can not possibly produce such topographic peculiarities. On the Mexican tableland, for instance, where the geologic structure presents a great thickness of soft later deposits, and the whole selberglandschaft of the Germans is probably more ideally perfect than anywhere else on the globe. A number of typical illustrations are described. The phenomena are best explained by the action of regional eolation, or general leveling and lowering of the country through deflation.

Some Upland Flats in Jo Davies County, Illinois: A. C. Trowbridge.

An attempt to distinguish between raised peneplains, structural plains, plains of marine deposition and plains of marine erosion, in regions of nearly horizontal strata.

The Value of Geochemistry to Geology and Geography: J. Culver Hartzell.

The author stated that geology is the history of the earth, including organisms; geography is that part of geology which deals with the surface of the earth, and man in particular, and his relations to topographical, cultural, political and climatic environments. We are apt to forget the relations which the atmosphere, the hydrosphere and lithosphere bear to each other. Diastrophism, vulcanism and gradation are important; but the geochemistry is as important as the mechanics when changes in the equilibrium of chemical systems and their relation to man are considered. Atoms are different manifestations of one primal force. The farther we get away from *primal* the more distinct *chemical* and *physical* seem. There are pure and applied methods of procedure; but the pure and applied principles are interdependent in the proper and accurate interpretation of facts. The value of geochemistry lies in the fact that it touches every division of geology in both its philosophy and its applicability. We need to get away from a sole contemplation of finished products. All forces are so balanced as to produce systems which are more or less stable; but which may be disturbed in such a way as to produce new systems which may in turn become more or less stable. These disturbances in equilibrium are as vital to the geologist as the system *per se*. We know a little about the balancing of forces; but the balancings are so multifarious as to be almost overwhelming, and it is only by careful, persistent investigation, interpretation and application of forces and the formulation of laws (perhaps tentative) that we can hope to know the genesis of any one system and its possible disturbance, thus accumulating a mass of data relative to many systems the final interpretation of which will make clear many of the heretofore apparently unsolvable problems. Stability, unstability and disturbance cross our path and we must determine their relations. The atmosphere, hydrosphere and lithosphere were discussed. The reactions which take place, the manner and time of occurrence, the phenomena and the final results are the problems of the geochemist. The solution of these problems has a direct bearing on topographical, cultural, political and climatic effects as well as on diastrophic, volcanic and gradational effects. They also have a direct bearing on the igneous, metamorphic and unconsolidated portions of the lithosphere as well as on the morphological and mathematical relations of minerals and their chemical molecular arrangement, and the conditions of fossilization with reference to the changes in the solid parts of organisms.

The author is greatly indebted to Dr. Frank Wigglesworth Clarke's "Data of Geochemistry," and to Alfred H. Brooks's presidential address before the Geological Society of Washington, December 13, 1911, for the thoughts here presented.

Gas and Oil Wells near Oberlin, Ohio: George D. Hubbard.

Exploitation of the Clinton sands of the Clinton formation northward from the Bremen field to Lorain County has gone far enough to find several good wells in the vicinity of Oberlin. Mostly gas of good quality; some yield oil too. Gas is found at a depth of about 2,170 feet below

surface which is at about 750 feet. Section contains much water in the limestones, also several feet of salt. Anticlinal theory does not seem to apply; gas is apparently in pockets or lenses of the sand in the calcareous shales. These sand beds are not continuous. Rock pressure varies in different wells from 600 to 950 pounds, and flow from 1,000,000 to 5,000,000 cubic feet per day.

The History of the Bajadas of the Tucson Bolson of Arizona: S. S. VISHER.

The bajada is the long, gentle slope of detrital material at the foot of the mountains in bolsons or areas of centripetal drainage. The bajadas near Tucson have a length of about 10 miles and an average slope of 2° or 100 feet per mile. In spite of a difference of 8° or more in slope between the lower four miles of the canyons and the upper four miles of the bajada, erosion is now taking place on all portions of these thick terrestrial deposits. The explanation for this widespread erosion has been sought by many. The higher portions would, as shown by Salisbury, be eroded as the highlands were lowered, but not the lower portions, nor are certain other features to be thus explained. Over-grazing does not appear to be a sufficient cause. Davis concludes that in maturity the adjustment between one bolson and an adjacent lower one may result in the terracing in the higher. Changes of climate have been advocated: Barrell considers that bajadas were formed during the various glacial epochs and have since been destroyed; Huntington believes bajadas were formed in the interglacial epochs, of material which accumulated in the mountains during the glacial epochs. The present terracing he correlates with a recent increase of precipitation. The latter apparently opposing theories for bajada formation are in this region seemingly both essentially correct—Barrell's of the bajadas surrounding the lower, barren, warmer ranges, and Huntington's those of the higher, forested, cooler mountains upon which glacial conditions were approached since the bajadas of the former are more gentle, have a smaller percentage of clay and are more extensively eroded than those of the larger ranges. The frequency of freezing temperatures are believed to be important. At Tucson a decrease of 10° F. would increase the frequency about 200 per cent. and a 20° decrease would result directly in frost about 250 nights in the year. A different distribution of the precipitation would greatly effect the vegetal covering. The percentages of clay and boulder formation would fluctuate accordingly as would also accumulation and transportation. The Tucson bajadas appear to have been mainly formed at a time when the average temperatures were 10° or more lower; when the precipitation was greater and more uniform—either chiefly late in the glacial epochs (smaller ranges) or at their close (larger ranges). The present terracing is perhaps due to an increase in temperature and a different distribution and amount of rainfall abetted by the advancement of the area in the geographic cycle.

The Relation of the Lime Creek Shales to the Cedar Valley Limestones of Floyd County, Iowa: A. O. THOMAS.

The Devonian system of Iowa is represented by sediments belonging to two series, the Middle and the Upper Devonian. The stages of the Upper Devonian do not overlie each other, but each is locally developed and geographically separate. Moreover, each lies unconformably on the Cedar Valley stage of the Middle Devonian. Field study in Floyd County on the areal distribution and geological relations of the Lime Creek stage of the Upper Devonian has demonstrated a widespread unconformity at its base. A new substage, for which the name Nora limestone is proposed, is added as the lowest member of the Lime Creek stage.

A Four Mile Section along the Missouri River South of Columbia, Missouri: E. B. BRANSON.

Strata are well exposed along the bluff of the Missouri River and are, in general, nearly horizontal. Eight distinct and well-exposed unconformities occur within four miles.

The Relation of Geological Activity to Conservation of Soil and the Waters of Flowing Streams: LUELLA AGNES OWEN.

A view of the advance of geology as a science, and of early geological research, shows the growing appreciation of the all-important power of water in the development and progress of continents as well as their destruction or partial denudation for continual rebuilding. All atmospheric forces unite their energy with that of the flowing streams in every land to work without rest in tearing down the high places of the earth and transporting the waste for renewal of valleys and building new coast lines. So, the present geological epoch is preeminently the Age of Rivers, and in necessary works of conservation man may change the application of natural law to meet his needs and pleasure, but the law itself is unchangeable.

Rock Classifications in Three Dimensions: Alexander N. Winchell.

Believing that tabular classifications are desirable because of their simplicity, but that, as previously devised, they are unnecessarily limited in their presentation of mutual relationships, a new classification of igneous rocks is presented which is in tabular form in three dimensions. It is based largely upon the principles and work of Rosenbusch, but it differs from his usage in various important respects, so that responsibility for it must lie with the author.

Geo. F. Kay,
Secretary Section E

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and sixty-second regular meeting of the society was held at Columbia University on Saturday, February 22, extending through the usual morning and afternoon sessions. The attendance included thirty-eight members. Ex-president H. S. White occupied the chair, being relieved by Professors E. W. Brown and Frank Morley. Sixteen new members were admitted: Professor E. P. Adams, Princeton University; Dr. H. L. Agard, Williams College; Professor Fiske Allen, Kansas State Normal School; M. Farid Boulad, Egyptian State Railways; Professor J. A. Caparo, Notre Dame University; Mr. C. H. Clevenger, Kansas State Agricultural College; Dr. A. L. Daniels, Jr., Yale University; Mr. W. Van N. Garretson, University of Michigan; Mr. G. M. Green, Columbia University; Mr. C. E. Love, University of Michigan; Dr. Thomas Muir, Education Office, Capetown, S. A.; Mr. J. A. Nyberg, University of Wisconsin; Dean Marion Reilly, Bryn Mawr College; Professor B. L. Remick, Kansas State Agricultural College; Professor W. V. Skiles, Georgia School of Technology; Mr. J. N. Vedder, University of Illinois. Five applications for membership were received.

The society is about to publish the lectures delivered at the Princeton colloquium in 1909 by Professors G. A. Bliss and Edward Kasner.

The following papers were read at this meeting:

Harris Hancock: "A theorem in the analytic geometry of numbers."

B. H. Camp: "The expression of a multiple integral as a simple integral."

G. M. Green: "Projective differential geometry of triple systems of surfaces."

C. A. Fischer: "A generalization of Volterra's derivative of a function of a curve."

L. B. Robinson: "Notes on the theory of systems of partial differential equations."

Oswald Veblen and J. W. Alexander, II.: "Manifolds of n dimensions."

R. G. D. Richardson: "Oscillation theorems for linear homogeneous self-adjoint partial differential equations with one parameter."

L. P. Copeland: "Concerning the theory of invariants of plane n-lines."

T. H. Gronwall: "On the summability of Fourier's series."

T. H. Gronwall: "On Lebesgue's constants in the theory of Fourier's series."

T. H. Gronwall: "On the degree of convergence of Laplace's series."

N. J. Lennes: "Note on Lebesgue and Pierpont integrals."

N. J. Lennes: "Finite sets and the foundations of arithmetic."

H. Bateman: "The expression of the equation of the general quartic curve in the form $A/xx' + B/yy' + C/zz' = 0$."

H. Bateman: "Sonin's polynomials and their relation to other functions."

Dunham Jackson: "On the accuracy of trigonometric interpolation."

C. E. Wilder: "On the degree of approximation to discontinuous functions by trigonometric sums."

Edward Kasner: "Systems of curves connected with equilong transformations."

The next regular meeting of the society will be held at Columbia University on Saturday, April 26. The Chicago Section will meet at the University of Chicago on Friday and Saturday, March 21–22. The San Francisco Section meets at Stanford University on Saturday, April 12.

F. N. Cole,
Secretary

THE ACADEMY OF SCIENCE OF ST. LOUIS

At a recent meeting of the academy held on February 17, 1913, Professor Nipher presented an abstract of a paper soon to be published by the academy, entitled "A Local Magnetic Storm."

The phenomena were produced by means of two steel magnets, placed on opposite sides of a magnetic needle, as in the Gaussian method of deflection. The needle was completely enclosed in a copper cylinder. Its motion was observed through a small glass window, covered with wire gauze, by

means of a telescope and scale. The needle was in the magnetic meridian, the two deflecting magnets being balanced against each other. The needle was also loaded with a few copper wires, and the earth's field was partially compensated, so that the period of oscillation of the needle was about twenty seconds. When one of the deflecting magnets is then connected with either terminal of an influence machine, the other terminal being grounded, its deflecting effect on the needle was increased. This effect was found to be varied by disturbances of the air in the room due to the movement of an assistant. The observed effect was not appreciably modified by wrapping the magnet in tinfoil. A puff of tobacco smoke over the deflecting magnet also changed the apparent deflecting effect. It gradually became apparent that a change in the permeability of the air was produced, when the magnet was put into contact with the influence machine in an adjoining room. Apparently, the electrified molecules of air arranged themselves along the lines of the magnetic field, with the planes of rotation of the electrical whirls within the molecules set at right angles to the magnetic lines. The permeability of the air was thus increased, in somewhat the same way that iron filings in the field of the magnet would increase it.

When the electrified air around the magnet is disturbed by a palm-leaf fan, the permeability of the air is decreased. By proper timing of these disturbing effects of the fan, the amplitude of swing of the needle may be gradually increased to four degrees of arc. By operating the fan during the other semi-vibration of the needle it may be brought quickly to rest.

Professor Nipher is now seeking to obtain photographs of auroral displays around the poles of a steel magnet.

GEORGE O. JAMES,
Corresponding Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

THE eighty-sixth regular meeting of the Botanical Society was held at the Cosmos Club, Tuesday evening, February 4, 1913.

The following persons were elected to membership: Professor R. Kent Beattie, Dr. Charles Brooks, Mr. J. G. Grossenbacher, Dr. Neil E. Stevens.

The following program was presented:

MR. T. H. KEARNEY: *Indicator Value of Natural Vegetation in the Tooele Valley, Utah.*

This paper outlined the results of an investigation conducted last summer by the Offices of Alkali and Drought Resistant Plant Investigations and of Biophysical Investigations of the Bureau of Plant Industry. The Tooele Valley lies between the Oquirrh and Stansbury ranges and extends to the south shore of Great Salt Lake.

It was found that the valley is occupied by some half dozen principal plant associations, each of which is characterized by the presence of one, or, at most, two dominant species of shrubs or perennial herbs. The presence of one or another association was found to be closely indicative of the moisture relations and salt content of the substratum. The areas occupied by the different associations are often so sharply defined as to be recognizable at a distance of several miles.

The presence of a good stand and growth of sage brush (*Artemisia tridentata*) is always associated with a soil of rather light texture, very dry during the summer months, free from alkali salts and with a low water table. This *Artemisia* association occupies mainly the higher lands of the valley. Descending the valley toward the shore of Great Salt Lake, successive zones are traversed which are occupied by the following associations: (2) *Kochia vestita*, (3) *Atriplex confertifolia* (Shadscale), (4) *Atriplex confertifolia* and *Sarcobatus vermiculatus* (Greasewood), (5) *Allenrolfea occidentalis*, (6) *Distichlis spicata* (Salt Grass) and two species of *Salicornia*.

Where associations 2 and 3 occur the soil is very dry during the summer, but has a higher moisture capacity than in the *Artemisia* association and the subsoil is strongly saline. Under association 4 the soil becomes saline to the surface and the ground water table is relatively high. Associations 5 and 6 occupy the wet and highly saline soils near the level of the water surface of the lake and are interrupted by bare expanses covered with a crust of salts (chiefly sodium chloride).

The suitability for crop production of the different types of land in this valley can be predicted with much confidence from the character of the native growth.

MR. HARRY B. SHAW: *The Control of Seed Production in Beets.*

Practically all sugar-beet seed used in the United States is imported. Successful attempts have been made in Utah, Idaho and Washington to produce sugar-beet seed, but in other regions

such attempts have not been very successful, inasmuch as many of the plants have failed to mature seed. Observations were made to ascertain the cause of this. In order to make the subject readily comprehensible attention was invited to the surprising responsiveness of the beet to environment; the responses may be grouped as follows:

1. The wild beet, a winter annual, ripening and dropping its seed early in autumn. The seed germinates before winter sets in, consequently the young seedlings are for many weeks exposed to a comparatively low mean temperature. In early spring—coincident with rising temperatures—the seed stem is put forth, the paucity of foliage being conspicuous.

2. The wild annual brought into cultivation soon assumes the biennial habit; its growth being in every known way stimulated from the sowing of seed onwards; planting is carefully planned so that the young seedling shall escape protracted periods of low temperature. In response, the roots become storehouses and fail to develop reproductive parts.

3. The cultivated beet, a biennial, not alone through selection, but more especially because its environments are entirely changed; it is withheld from those periods of restrained growth seen to operate upon the wild beet in its native habitat; instead, its growth is stimulated.

4. The cultivated beet reverts to the annual habit, whenever it is exposed in the seedling stage to conditions more or less identical with those of the wild beet at the same stage of growth.

5. Even when the beet is planted out the second spring for the production of seed, there are occasions and localities which cause in those beets a greater or less tendency toward non-seeding, ranging from almost normal seed production to absolute foliage conditions.

6. When placed under conditions where growth stimulus is great and constant, as in a well-heated greenhouse, the cultivated beet becomes perennial in habit, producing, year after year, nothing but foliage.

Mr. Shaw sought in these varied manifestations a common factor, or group of factors, which acting at a critical period in the life of the plant, might be found to control the manner of its development. Experiments were carried on in Utah during 1912 to determine, if possible, the nature of the conditions responsible for the variations mentioned.

It was discovered that the condition absolutely necessary for the perfect development of the reproductive parts is a period of restrained growth in the bud rudiments of seedlings, or the buds in the crown of so-called mother beets. While in general this condition is brought about by low temperatures (a mean temperature of 38 to 45° F. apparently being required for the sugar beet) when prevailing for several weeks, the necessary degree of growth inhibition may be brought about by other factors, such as pathological conditions, drouth, starvation. The withdrawal of such a period of inhibited metabolism, according to degree, will result in the greater or less degree of approach to foliage conditions, as opposed to the development of reproductive parts.

Thus, by a study of climatic conditions, suitable locations where the production of seed may be assured, can be selected with a considerable degree of certainty. The proper time to plant the mother-beets can also be indicated, so that we may be reasonably certain that the beets will produce seed.

This necessity for a period of inhibited metabolism, and the fact that it may be brought about by the conditions mentioned, may explain the remarkable inflorescence of moribund fruit trees, or of trees that have been girdled, also the abnormal behavior of plants carried from a cool to a warm climate.

C. L. SHEAR,
Corresponding Secretary

PHILOSOPHICAL SOCIETY, UNIVERSITY OF VIRGINIA
MATHEMATICAL AND SCIENTIFIC SECTION

THE fifth meeting of the session of 1912–13 of the Mathematical and Scientific Section was held February 17.

Professor W. H. Echols read a paper entitled "The Evolutionary Construction of the Imaginary Power of a Number and Its Expression as the Exponential Function."

Professor Thomas L. Watson read a paper by himself and Professor Stephen Taber on "Magmatic Names Proposed in the Quantitative System of Classification for some New Rock Types in Virginia."

Professor Watson presented a second paper by himself and Mr. Justus H. Cline. The subject of this second paper was "Petrology of a Series of Igneous Dikes in Central Western Virginia."

WM. A. KEPNER,
Secretary

UNIVERSITY OF VIRGINIA

SCIENCE

FRIDAY, MARCH 28, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

GALILEO, THE PHYSICIST[1]

THE mission of an academy of science is a function of the age in which it flourishes. The ancient academies accomplished a work now performed by the universities. The Italian academies of the Renaissance, variously estimated at from 500 to 700 in number, represent different purposes almost as numerous as the institutions themselves. But in general they were literary and scientific clans; they belonged to a period when learning was the possession of the few, to a period when one might still take all science for his domain.

The modern academy is, as a rule, closely allied with the sovereign power of some state, whose interests are promoted by it, consciously and unconsciously, in a variety of ways. The service which it renders is sometimes political, sometimes literary, sometimes scientific, sometimes social. But, so far as I can see, they all have, in common, these two ends, namely, the encouragement of the individual and service to the community.

The triple purpose of the Illinois State Academy of Science is clearly stated in the second article of its constitution as being "the promotion of scientific research, the diffusion of scientific knowledge and of the scientific spirit, and the unification of the scientific interests of the state"; just how this object can best be secured is the interesting subject of an after-dinner discussion this evening.

I leave this problem, therefore, with the

[1] Presidential address, delivered before the Illinois Academy of Science, at Peoria, February 21, 1913.

single remark that the importance of cultivating individual initiative and of handing on to the community the best there is in the achievements of science is not likely to be overestimated.

Symonds[2] points out that Athens and Florence owed their wonderful intellectual, artistic and literary success mainly to the fact that they nourished the individuality of their citizens; while Sparta and Venice, comparatively barren of permanent results, illustrate the lack of such encouragement.

I now invite your attention to one of the earliest members of the venerable and thankworthy Academy of the Lyncei, a man who represents in the highest degree the individuality then cultivated in Tuscany, a man whose impress upon his students was so deep that shortly after his death they united to form one of the most productive and justly celebrated of all the Italian academies,[3] a man whose written works fill twenty splendid quarto volumes,[4] a man who in his efforts to put before the people the best science of his times, endured opposition, criticism, disgrace and social ostracism throughout most of his thinking life. I refer to Galileo. But I shall speak only of what he did in physics, because I believe this phase of his work is too little known.

What Galileo saw through telescopes of his own make, though not of his own invention, is so familiar that possibly a majority of intelligent men think of him mainly as an astronomer. The spots on the sun, the mountains on the moon, the satellites of Jupiter, the phases of Venus, the "triple character" of Saturn, the solar rotation period, lunar libration and earthshine are some of the celestial phenomena associated with the name of Galileo. These and his brilliant defense of the Copernican system are responsible for the impression that his accomplishments are chiefly astronomical.

To another large group of men he stands mainly for liberty, intellectual, social and religious. These men classify him with Giordano Bruno and De Dominis and Campanella who also had some experience with the cardinals of the Inquisition. For them Galileo is the man who dared to differ with Aristotle, the man who brushed aside the mists of philosophy, the man who banished church traditions from his thinking while he calmly pursued his search after unity in the physical universe.[5] It is doubtless his splendid stand for spiritual freedom which leads Goethe[6] in his historical sketch of optics to say:

> Even though he never seriously studied the subject of color, I must at least adorn my page with his name.

But there is still a third group of men to whom the great Italian appeals most strongly because he has given them a new method of working and thinking, a new viewpoint, a new *aperçu*. To put this contribution in its proper perspective is not an easy matter; we are too near it and too familiar with it. If, however, one considers the time interval between Archimedes and Kelvin he can not fail to notice a sharp discontinuity in the progress of physics occurring about the beginning of the sev-

[2] "Renaissance in Italy," Vol. I., p. 234.

[3] *Accademia del Cimento*, founded in 1657; disbanded in 1667.

[4] Edited by the scholarly care of Professor Favaro, of the University of Padua, and published by the Italian government, 1890–1909. Referred to hereafter as "Nat. Ed."

[5] For a masterly presentation of this phase of Galileo's work, see Dr. Charles T. Little's article in the *Methodist Review*, Vol. 88, pp. 204–218, 1906.

[6] Goethe, "Farben-lehre Historische Theil," art. Galileo.

enteenth century. Just how commerce and industry led up to, and prepared the way for, this step is the subject of a most interesting chapter by a member of this academy, Professor Mann.[7]

Without underestimating the contributions of Pappus or Tartaglia or Benedetti or Stevinus or Leonardo da Vinci, to mechanics; and without denying the important rôle of statics in architecture and in other structural work, one may, I believe, fairly say that the years which intervene between Archimedes and Galileo are practically barren of progress in physics.

It is true, indeed, that during this interval a large number of isolated physical facts had been discovered; indeed, there is scarcely a chapter in physics in which some advance of this type can not be mentioned; but, during all this while, nothing in the way of development is seen; individual discoveries remain isolated; they do not bear fruit; speculation and guessing were still employed where we use observation and measurement and computation. Leonardo da Vinci likens a scientific conquest to a military victory in which theory is the field marshal; experimental facts, the soldiers. The philosophers who preceded Galileo had, in the main, been trying to fight battles without soldiers. The only possible exceptions to this statement are Roger Bacon, Leonardo da Vinci, Stevinus and Gilbert. They had measured some mechanical quantities—a few of them—masses and stresses—such as could be obtained by means of a steel-yard and a measuring stick; but they were still in the domain of statics. Now from a geometrical, esthetic or even utilitarian standpoint it is difficult to imagine any finer subject than graphical statics; and yet when we regard the progress of physics, statics is to dynamics somewhat as osteology is to physiology, a veritable valley of dry bones. The live part of mechanics is kinetics, the study of masses which are in motion, the consideration of bodies which are changing their velocities, currents of water, oscillating magnets, vibrating strings, rotating wheels, electric motors, heat engines, electromagnetic waves, and X-rays. These are the problems over which men lose sleep; these are the questions which compel the interest of the physicist; these are the subjects whose mastery confers power upon the engineer. The one confessed aim of physical science is, indeed, to describe the motion of bodies in the simplest possible manner. Indeed, it is only by the aid of this modern science of the energy of motion that any of the ancient mechanical doctrines—such as the atomic theory of Democritus—have acquired validity; it is this same science which has rendered the heliocentric theory of Copernicus not merely "a plausible view" but the one possible view.

[7] Mann, "Teaching of Physics," pp. 107–110 (Macmillan, 1912).

We pass now to a more definite question, namely, what contribution did "our Academician" make to the solution of problems of this type, to the science which now goes by the name of physics? To answer briefly and baldly, he instituted the method and set into motion the machinery by which practically all these problems have been solved, in so far as they have been solved at all. But lest I give the false impression that Galileo was the ancestor of all the physical sciences, I hasten to a more detailed answer of the query, What did Galileo?

1. First, no greater mistake could be made than to suppose that Galileo was the first man to differ with Aristotle; the academy of Cosenza, having opposition to the peripatetic philosophy as its avowed purpose, was established at Naples about

the time when Galileo was born; but he *was* the first man to offer *experimental evidence* against the conclusions of Aristotle; and in so doing he established what we now call the experimental method. He was not handing on an opinion which some "dusty-minded professor" had inherited from an ancestor of the same type.

Only two methods of investigation were known to the ancients, the philosophical and the mathematical; to these Galileo added a third, the experimental. The philosophical method consisted in assuming certain general principles and trying to find in them an *a priori* explanation of the universe. Briefly described, the attempt was to stare nature out of countenance. Failure was inevitable, not for want of intellectual acumen, but because, as every one in this assembly knows, it sometimes requires a lifetime of effort to explain a single detail. Witness almost any chapter in Darwin's "Origin of Species." Details must be mastered before one can pass to general principles.

The mathematical method consisted only in applying geometry to certain well-known areas, volumes and angles, especially to those angles observed in the sky, but always with the idea of describing the known rather than of discovering the unknown: the mathematicians do not appear to have put any deliberate questions to nature; or as Rowland said:

> A mathematical investigation always obeys the law of the conservation of knowledge: we never get out more from it than we put in. The knowledge may be changed in form, it may be clearer and more exactly stated; but the total amount of the knowledge of nature given out by the investigation is the same as we started with.

The experimental method, established mainly by Galileo, not only combines the observations of the philosophers with the measurements of the mathematicians, but adds deliberate experiment with a distinct purpose to interrogate nature concerning some detail of her behavior. Generalizations based upon these details the experimenter reserves for a later date. The high regard in which Galileo held experimental facts is reflected in the following from a letter[8] to the Grand Duchess Christina, dated 1615. He says:

> I would entreat these wise and prudent fathers to consider diligently the difference between opinionative and demonstrative doctrines, to the end that they may assure themselves that it is not in the power of professors of demonstrative sciences to change their opinions at pleasure.

Or witness the following paragraph from the "Saggiatore"[9] as illustrating the great weight which Galileo attached to experimental evidence. He says:

> We examine witnesses in things which are doubtful, past, and not permanent, but not in things which are done in our presence.
>
> If discussing a difficult problem were like carrying a weight, then since several horses will carry more sacks of corn than one alone, I would agree that many reasoners avail more than one; but discoursing is like coursing, and not like carrying; and one barb by himself will run faster than a thousand Friesland horses.

In all his thinking nothing is exempt from experiment. Astronomy even, in his hands, ceases to be a purely observational science; for when he wishes to discover whether the bright portions of the moon's surface are rough or smooth, he sets up two surfaces, one rough and one smooth; then illuminates them with Italian sunlight. Desiring to learn at what rate falling bodies gain speed, he devises a time-measuring machine, invents a method of "diluting gravity" and actually measures the rate at which speed is gained. His discussions begin and end with experiment—

[8] "Nat. Ed.," Vol. 5, p. 326. Translated in Fahie's "Galileo," p. 157.

[9] "Nat. Ed.," Vol. 6, p. 340. Translated in Fahie's "Galileo," p. 187.

a method so familiar to us that we forget how recent and powerful it is.

His two great dialogues—one dealing with astronomy, the other with mechanics—abound in experiments—most of them apt and clever. Leonardo da Vinci advocates experiment: Galileo uses experiment.

2. The second great achievement of Galilei was his seizure upon momentum as the fundamental quantity in the science of mechanics, and his demonstration that velocity is a factor in momentum. Galileo was by no means the first to study and discuss kinematical problems.

Benedetti (1530–1590), one of the many distinguished alumni of the University of Padua, had not only expressed dissatisfaction with the artificial distinction between "violent" and "natural" motions, but had gone farther and had paved the way for mechanics and the differential calculus by recognizing the fact of continuous variation in motion: Benedetti[10] had in particular studied oscillatory motion and had shown that such a motion is continuous even when the vibrating particle is at rest at the end of its path. He had, in fact, introduced the modern idea of continuous variation. But none of the predecessors of Galileo had, so far as I have been able to discover, pushed their study of moving bodies beyond the mere consideration of change of position. None of them had recognized the inertia of the moving body as a fundamental—perhaps the fundamental—fact of mechanics. Princes and paupers, for ages, had stumped their toes against bricks and stones: they were doubtless quite as familiar as we with the mere fact of inertia. But to Galileo it was a cardinal fact, because he was the first to see that the future history of a body depends upon its possession of inertia. To him the importance of a motion is, in general, measured by the inertia involved, or, as was then said—the weight involved. Hence he assigned to the product of the weight and velocity of a body the name "momentum," which is merely the Latin word for importance; as a synonym he sometimes uses the word *impetus*, thus emphasizing the impetuosity of motion.

But Galileo never got beyond the point where he measured inertia by weight, as, indeed, engineers still do—all, at least, except electric engineers. The invention of the idea of mass was reserved for Newton. Even Huygens,[11] who first mastered the idea of centrifugal force, never got beyond the point where he measured centrifugal forces in terms of weight, thus avoiding the conception of mass in all his work.

Those who wish to see just how clearly Galileo conceived that the future behavior of a body is connected with its inertia should read those propositions in his "Mechanics"[12] in which he calculates the path of a projectile by assuming that the horizontal speed of a shot, after it has left the muzzle of a gun, continues to be uniform. His repeated use of this principle makes it perfectly clear that he discovered what we now call—and perhaps properly call—Newton's first law of motion. Galileo failed to generalize it by extending it to all bodies, whether subject to the earth's gravitation or not. This Newton did because he had acquired the new concept of mass—that constant property which never deserts a body in any position or condition.

3. The next great step which Galileo

[10] Lasswitz, "Atomistik," Bd. 2, pp. 14–23, gives a good description of Benedetti's work.

[11] Huygens, "Horologium Oscillatorium," Part V., Prop. 12; or Hobart, "School Science and Mathematics," Vol. 11, p. 692 (1911), for translation of Huygens's paper.

[12] Galileo, "Dialogues on Motion," Fourth Day, Problem I. et seq.

made was the discovery of the constant factor in the motion of falling bodies. One of his earliest experiments, performed while still a young man at the University of Pisa, was to allow a bronze ball to roll down a carefully prepared inclined plane, an experiment from which he cleverly inferred that while the position and speed of the ball were changing, the time-rate at which it gained momentum remained constant. It was with reference to these particular experiments that Goethe remarked "*dem Genie, ein Fall für tausend gelte.*" The experiment is completed by showing how one can compute the momentum (or speed) of a body after it has been falling for any given time or through any given distance. In all these computations, the unit of momentum employed is that which a body acquires in falling freely through an arbitrarily selected unit of distance.

As illustrating how tenaciously he clings to the idea of momentum, witness the following clear, exact and thoroughly modern definition dating from the year 1604:[13]

> I call a motion uniformly accelerated when starting from rest its momentum, or degree of speed, increases directly as the time, measured from the beginning of the motion.

Observe that we have here, without any mention of the word, precisely the dynamical idea which we to-day use under the name of a "*constant force.*" There is, indeed, no necessity for the name; for Galileo attempts nothing more than to discover how the momentum of a body changes, owing to the presence of another body such as the earth in the neighborhood (action at a distance) or owing to contact with an elastic body such as the hot gases of exploding gunpowder in the barrel of a gun (action through a medium). Later generations had not yet beclouded the idea of force with "tendencies to motion"; they had not yet identified it with that vastly more complex "muscular sensation"; they had not yet made it over in the form of a "man"; they had not yet named it an "agent"; they had not yet identified it with a state of stress or strain which one elastic body exhibits when held permanently at rest by another elastic body; still less had there been any attempt to convince people—principally high-school lads and college students—that all these various things are one and the same, since, forsooth, at various times we call them by one name, "force." Some of Galileo's most worthy successors, such as Clifford,[14] Poincaré[15] and Hertz, have pointed out our inconsistent definitions of force, and have advocated in the most outspoken manner, a return to the simple methods of this Italian academician.

The best known of all his experiments is, of course, that in which he proves that the time of fall is independent of weight, an experiment which completes to a first approximation the laws of falling bodies practically as we have them to-day. He accomplishes a second approximation by eliminating the buoyant force of the medium. He is prevented from making a third approximation only because he meets the barrier of viscosity, a barrier which still renders impossible the solution of any but a few simple cases in fluid motion.

The one remaining fundamental phenomenon of falling bodies is that the acceleration of gravity is independent of the substance of which the falling body is composed. This Galileo[16] proved by swinging, side by side, two pendulums, having bobs

[13] "Nat. Ed.," Vol. II., p. 166.

[14] Clifford, *Nature*, Vol. 22, p. 122 (1880).

[15] Poincaré, lecture before the Wissenschaftlich Verein in Berlin, p. 116 (Teubner, 1912).

[16] "Nat. Ed.," Vol. 8, pp. 128–130, First Day, translated into German by von Oettinger, Ostwal's *Wiss. Klassiker*, No. 11, p. 76

of lead and cork, respectively. When the suspension fibers had equal lengths and the pendulums swung through equal amplitudes, they had equal velocities at each point of their path. It is difficult to find, in Newton's hollow pendulum experiment, much more than a second approximation in which he eliminates the air resistance from this experiment of Galileo.

4. The fourth advance which we owe to Galileo is the observation that the momentum communicated to a body in one direction does not alter its momentum in a direction at right angles. This independence of components of momenta, now known as Newton's second law of motion, was in the hands of Galileo no mere philosophical theorem, no vague guess, but a practical rule of action to be employed in mechanical operations. It is by compounding a uniform horizontal velocity with an accelerated vertical velocity that he proves, for the first time, that the path of a projectile is a parabola. It was by means of this principle that he prepared a range-table for gunners. The fact is then that Galileo discovered and employed the first two of Newton's laws essentially as we use them to-day.

It requires more than sheer strength to climb a difficult mountain peak; one must start in on the right trail. More than mere intellectual ability is needed to make an important discovery in physical science; one must start in with the correct viewpoint. This viewpoint is precisely what Aristotle lacked and exactly what Galileo possessed. It is Gomperz,[17] the distinguished historian of Greek thought, who says:

> The physical doctrines of Aristotle are a disappointing chapter in the history of science. They display to us an eminent mind wrestling with problems to which it is in no wise equal.

5. As a minor achievement of Galileo allow me to mention some discoveries to which he blazed a part of the road.

In a letter to a friend he says he had spent more years in the study of philosophy than weeks in mathematics. It is, therefore, extraordinarily surprising to find set forth in his "Dialogues on Motion"[18] all the detailed facts and ideas which are involved in the modern definition of an infinite quantity developed by Boltzano, Cantor, and Dedekind, viz., an assemblage containing a part which may be put into one-to-one correspondence with the whole.

Again he paves the way, in a very distinct manner, for the differential calculus, in pointing out that the definitions[19] of constant velocity and constant acceleration hold only when the times considered are "all whatsoever." If, therefore, one wishes to employ these definitions in the discussion of variable motion he must take his time intervals indefinitely small.

The invention of the well-known thermoscope which Galileo employed in his lectures at Padua also belongs here; for while it is not a true thermometer it doubtless led immediately to those exquisite sealed instruments shortly afterwards constructed by the Accademia del Cimento and still preserved in the Tribuna di Galileo at Florence. The theory of "dimensions," first stated by Fourier, was led up to in the First Day of the Dialogues on Motion.

The principle employed in his measurement of the density of air[20] is one which is not only faultless in principle, but one which makes it plainly evident that Galileo had properly conceived that idea of atmospheric pressure which, in the hands

[17] "Greek Thinkers," Vol. 4, p. 108, Berry's translation.

[18] First Day, "Nat. Ed.," Vol. 8, p. 78.

[19] Third Day, "Nat. Ed.," Vol. 8, p. 191.

[20] "Nat. Ed.," Vol. 8, p. 124, First Day.

of two of his students, led to the invention of the barometer, and, in the hands of von Guericke, to the air pump. Torricelli knew well the Dialogues on Motion.

6. Finally, Galileo was an inspiring teacher and built up at Padua a great school of physics. Many of his students lodged under his own roof; helped him in his own garden; ate at his own table. He had his own workshop and employed his own mechanicians. Generous with his time, his energy and his money, master of a fine literary style, endowed with a keen sense of humor, familiar with the best that had been said and thought in the world, standing in the front rank of investigators, is it any wonder that young men of talent hastened to Padua from all parts of Europe? Could any higher compliment be paid to a teacher than the devotion exhibited by the youthful Viviani, a lad in his teens, for his master already some seventy years old and a "Prisoner in Acetri"? If deferred payments of the kind that teachers mostly depend upon ever get as far as the next world, surely this courageous spirit, harried throughout his long life by poverty, ill-health and the censorship of the church, must have been gratified by the work of the Accademia del Cimento which was, with the exception of a single man, composed entirely of his students. Mechanics was the one subject to which he was devoted consistently and persistently throughout his life; it was the subject of his earliest investigation when a young man at Pisa; the subject upon which he lectured when in his prime at Padua; the subject of his latest and most mature reflection at Arcetri. His most important contribution to dynamics was published in the seventy-third year of his age.

If, in conclusion, I were asked to summarize in a single sentence the principal contributions of Galileo to the science of physics, I should mention the two following facts: (1) That knowledge of physical phenomena which is to receive "impersonal verification" and become useful, must be obtained mainly by experiment adapted to ask of nature some particular question. (2) That momentum considered as a function of time and position is a fundamental dynamical concept; or, in other words, to discover how the change of momentum of any body is connected with the physical circumstances in which the body is placed, is the one great problem of dynamics.

But perhaps, after all, his most important contributions lie outside of physics. Indeed Galileo has not yet shot his last arrow. For his life still teaches us that nothing is so because any man says it is so. His example still shows how experiment can rob a man of all arrogance of opinion, how familiarity with unsolved problems can give a man genuine humility, and how, on the other hand, the possession of clear experimental evidence arms him with sure confidence.

Critics tell us that Florence, during the Renaissance, shone with a borrowed light—a light reflected from Athens. But I venture to think that those who will take the pains to look over the pages of Galileo will find them self-luminous.

HENRY CREW
NORTHWESTERN UNIVERSITY

FACTS AND FICTION ABOUT CROPS

THE Association of Official Agricultural Chemists of the United States at the Norfolk meeting, in 1907, unanimously adopted a commiteee report[1] endorsing the following declaration:

> It is as truly the duty of science to protect agriculture from error as it is to afford new truth.

[1] See Circular No. 123 of the University of Illinois Agricultural Experiment Station.

If "the farm is the basis of all industry," as was recently stated by James J. Hill, then science should not fail in this duty; for American agriculture is approaching a crisis, and the use of science must be depended upon to provide adequate support for our rapidly increasing population.

Already the question of food has begun to exert dangerous pressure in the United States, but so much of error and deception has been promulgated that even those who are to occupy the places of highest authority and influence are likely to be led into false positions whose foundations can only crumble beneath their feet.

There is no fiction in the starving poverty of our race in India, nor in the frequent famines of Russia, nor in the history of the dark ages following the ancient civilization of our people in the Mediterranean countries; and neither should the plans for the future prosperity of the Aryan in America be based upon fiction.

EXAGGERATED CROP REPORTS

Careful investigation reveals the fact that the reports from the federal bureau of statistics, as published by the secretary of agriculture, are highly exaggerated and deserving of the strongest condemnation, although all would be glad to give praise if these glowing reports were true; and, if the progeny of ninety-two million people and added millions of immigrants could live upon blind optimism or mere boasting, then duty would not compel this contribution toward the protection of truth and prosperity, by exposing error.

The following quotations are taken from the annual reports of the secretary of agriculture:

From 1905 Report.—Another year of unsurpassed prosperity to the farmers of this country has been added to the most remarkable series of similar years that has come to the farmers of any country in the annals of the world's agriculture. Production has been unequaled; its value has reached the highest figure yet attained.

From 1906 Report.—Economic revolution in the art and science of agriculture, which became noticeable in this country half a dozen years ago, has continued during 1906, with tremendous effect upon the nation's prosperity. Crops so large as to be beyond any rational comprehension have strained the freight-carrying ability of the railroads.

From 1910 Report.—Year after year it has been my privilege to record "another most prosperous year in agriculture." . . . Nothing short of omniscience can grasp the value of the farm products this year. At no time in the world's history has a country produced farm products within one year with a value reaching $8,926,000,000, which is the value of the agricultural products of this country for 1910. This amount is larger than that of 1909 by $305,000,000, an amount of increase over the preceding year which is small for the more recent years.

A notable feature of corn production this year is the growing importance of the south. This has been manifested in a small way in very recent years, but now the increased magnitude of the crop in that section, both absolute and relative to national production, forces itself upon the attention.

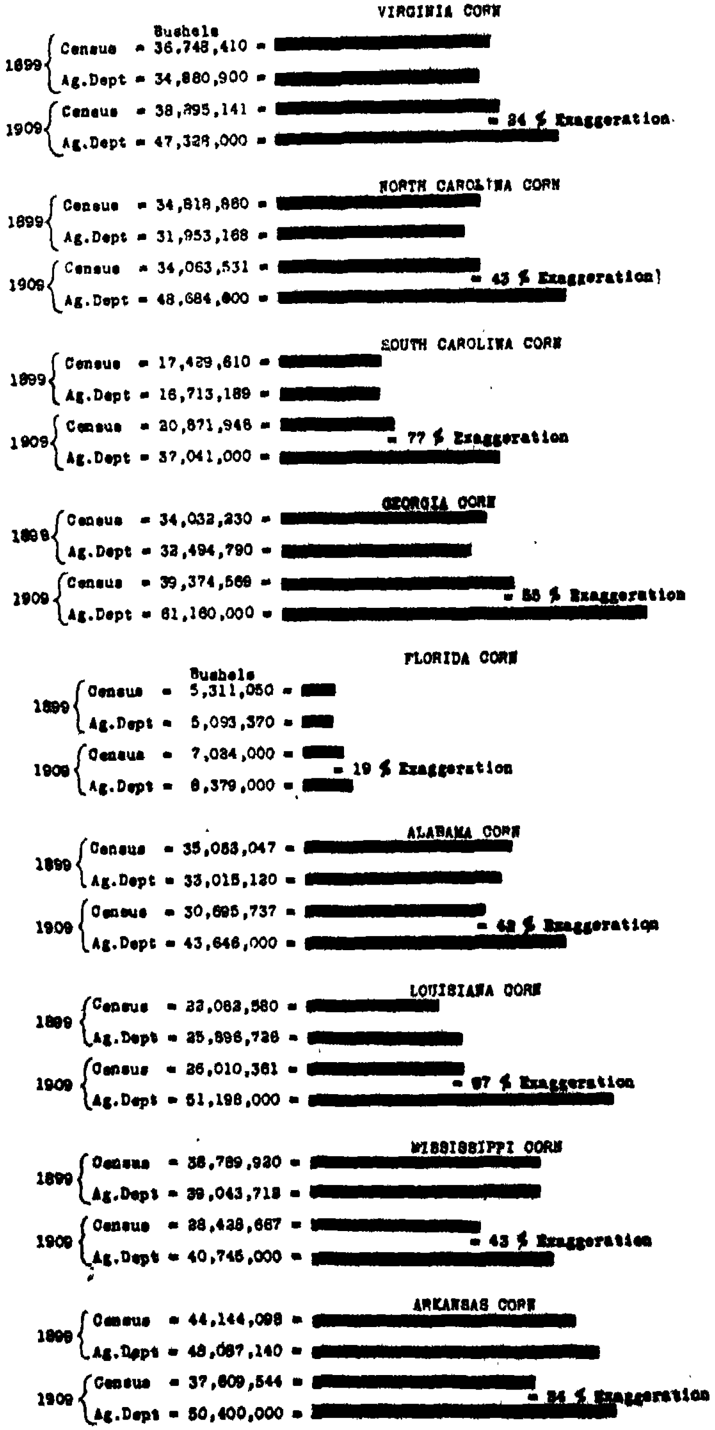
The demonstration work among southern farmers is rapidly increasing. Organized in 1904 for the purpose of fighting the boll-weevil in Texas, this work has now extended to all of the southern states. . . . From 1904 to 1909 there was an increase from 1 to 362 agents in the field. The number has now reached 450, and the demand for more is urgent. . . . In 1909 figures from a large number of demonstrators showed a comparative increase of from 50 to 400 per cent. in the average yield of standard crops, and the figures for 1910 indicate similar results.

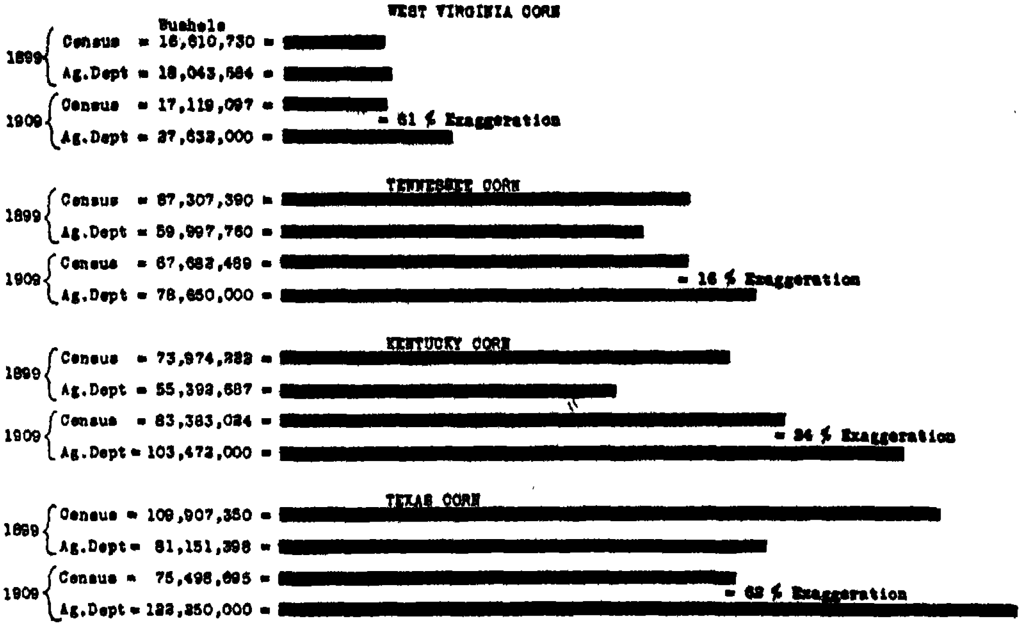
From 1911 Report.—Owing to the prevalence of high prices there has developed a general impression that the agriculture of this country is unequal to the needs of the increasing population. An investigation of the facts with regard to this condition failed to establish any cause for alarm. On the contrary, it is evident that this country has been passing through phases of agriculture in which declines in production per acre are the result of exploiting new land and in which recuperation follows with a greater pace than that of increase of population.

The Department of Agriculture has had success in the south through object lessons in the field, where the best southern farmers in their counties were the instructors. This method should be organized in all the states.

From 1912 Report.—The record of sixteen years

FACTS AND FICTION ABOUT CORN
By U. S. Census and Agricultural Department





has been written. It begins with a yearly farm production worth $4,000,000,000 and ends with $9,532,000,000. . . . During the past 16 years the farmer has steadily increased his wealth production year by year, with the exception of 1911. . . . Beginnings have been made in a production per acre increasing faster than the natural increase of population.

In the issue of February, 1913, of the *Crop Reporter,* "published by authority of the secretary of agriculture," occurs the following:

Statements have been made recently by some writers and lecturers, to the effect that the yield per acre of crops in the United States is diminishing from year to year. A study of crop yields indicates that there was such a tendency toward lower yields during the seventies and eighties, but during the last 20 years the tendency has been the reverse. . . . In order to show this trend graphically, eight charts are published in this issue of the *Crop Reporter* which show the yearly change and the average change of yield per acre of eight important crops. In these charts the downward tendency until about 1890, and since then the upward trend, is strikingly shown. The recent tendency toward enlarged production per acre is general throughout the United States.

By referring to the *Crop Reporter* for January, 1911, we find a similar statement:

That the final stage of better agriculture and increased production has been reached in many states for a varying number of crops, and that production per acre is not only beginning to exceed the normal increase of population, but really to exceed the actual increase. . . .

The potentiality of agricultural production as a national achievement sufficient for growth of population has been so numerously and so thoroughly demonstrated as to be now beyond intelligent question. The Farmers' Cooperative Demonstration Work, now carried on in 12 cotton states, employs 375 traveling agents and has many thousands of demonstrating farms. It is proving by results on thousands of farms that preparation of the soil so as to make the best seed bed adds 100 per cent. to the average crop on similar lands with an average preparation in the old way; that the planting of the best seed makes a gain of 50 per cent.; and that shallow, frequent cultivation produces an increase of another 50 per cent., making a total gain of 200 per cent., or a crop three times the average crop.

It will be noted that all of this enormous increase is secured with no suggestion of soil enrichment, in strict harmony with the erroneous teachings[4] of the Department's Bureau of Soils:

[4] See Bureau of Soils Bulletin, No. 55, pp. 66, 79, 80; or SCIENCE, November 8, 1912, p. 621.

The soil is the one indestructible, immutable asset the nation possesses. It is the one resource that can not be exhausted; that can not be used up. . . . It is evident that it can not wear out, that so far as the mineral food is concerned it will continue automatically to supply adequate quantities of the mineral plant foods for crops. . . . As a national asset the soil is safe as a means of feeding mankind for untold ages to come.

CROP ESTIMATES MEASURED BY THE CENSUS

Fortunately, there is a trustworthy measure applied to the progress or retrogression of this country every ten years, when every farmer and land owner in all the states must make a sworn statement to the Bureau of Census in regard to his crops and herds; and, fortunately this statement is not subject to subsequent revision or inflation by any "estimates" of the "Crop Reporting Board" with an "optimistic" secretary of agriculture as the chairman.

Thus, while the "crop statistics" of the agricultural department claim an increase of 50 per cent. in the production of corn in the southern states from 1899 to 1909, the data from the U. S. Bureau of Census show an actual decrease of 7 per cent. In other words, the Department of Agriculture reports that the total production of corn for the thirteen states from Texas and Arkansas to the Atlantic, and south of the Ohio and Potomac, was increased by 239 million bushels from 1899 to 1909; while the figures from the Bureau of Census prove that instead of an increase there was a positive decrease of 31 million bushels.

The accompanying statistical data and graphic illustrations reveal the percentage of inflation or boasting by the agricultural department as compared with the census facts relating to corn production in the individual states.

STATISTICAL ILLUSTRATIONS

The census reveals an increase in the population of contiguous continental United States of 21 per cent. during the last decade (from 76 million to 92 million people). The Bureau of Census also found an increase of 4.8 per cent. in farm land, and increase of 15.4 per cent. in *farmed* land, which means the land used for the production of crops, including pasture for live stock.

But has our increased production per acre amounted to more than 21 per cent., as the above quotations would lead us to believe? If so, our total increase in production should be 39.6 per cent., considering that we are farming 15.4 per cent. more acres. But the report of the Bureau of Census shows only 1.7 per cent. increase in the total production of all cereal crops, including corn, wheat, oats, barley, rye, rice, buckwheat, Kafir corn, emmer and spelt, the aggregate production having been 4,439 million bushels in 1899 and 4,513 million bushels in 1909; and a comparison of the crop "statistics" of the Department of Agriculture for these years with the averages for the three-year periods, 1898 to 1900, and 1908 to 1910, respectively, shows that, on the whole, 1909 was a slightly more favorable season than was 1899, for the production of the cereal crops.

An increase of 15.4 per cent. in farmed land with an increase of only 1.7 per cent. in production reveals the truth of reduced yield per acre. And neither official "estimates" nor official boasting can controvert this established American fact.

SHORTAGE OF ANIMAL PRODUCTS

We might expect and hope that a much larger increase would be found in the live stock produced during the decade on the farms of the United States, but instead we find no increase at all. In fact, the number of cattle decreased by six million (from 68 to 62 million head); the swine decreased by five million (from 63 to 58 million head); and the sheep decreased by nine million (from 62 to 53 million head); while horses and mules increased by less than three million (from 22½ to 24 million on farms, and from 25 to 27½ million all told, including those in cities).

(The time of year the counts were taken varied by six weeks, June 1, for 1900, and April 15, for 1910, but even with possible allowances for this variation, the number of

cattle, sheep and swine plainly decreased during the decade.)

THE TRUTH ABOUT COTTON

The cotton crop showed a substantial increase of 11.7 per cent. in total production, and, furthermore, 1909 seems not to have been a favorable season for cotton; but, on the other hand, the acreage in cotton increased by 32 per cent. from 1899 to 1909; and the combined reports of the Department of Agriculture (on acreage) and of the Bureau of Census (on production) reveal the fact that the yield per acre of cotton was not only less in 1909 than in 1899, but the average yield per acre for the four years 1907, 1908, 1910 and 1911, was also less than the average for the four years 1897, 1898, 1900 and 1901. This notwithstanding the boasted influence of the hundreds of "best southern farmers in their counties," who accepted appointments on the Department's pay roll as "field agents"; and it is a question of exceeding importance whether the "farm demonstrators" of either the south or the north should be appointed by the secretary of agriculture. Should they not rather be appointed by the agricultural colleges of the respective states, in order that they may be selected because of their thorough training in the scientific principles which must constitute the foundation of truly permanent systems of agriculture, as well as for their knowledge and experience in the science and practise of agriculture in their own state, and be held directly responsible to their home people? There is the gravest danger that a federal appointee in every county will often exert more influence politically than agriculturally.

POTATOES INCREASE

The reports of the Bureau of Census show that the only important increase in crops of large significance for food is in potatoes, a crop that is grown to a considerable extent on the market gardens enriched by heavy applications of animal fertilizers from the city, produced, of course, at the expense of the farms which supply the cities with hay and grain.

DECREASE IN EXPORTATIONS

When we consider the facts revealed by the Bureau of Census, it is not strange that, in order to feed our increasing population, we were compelled to decrease our exportation of wheat for making bread, and of corn for making meat. As an average of the first four years of Secretary Wilson's administration (1897 to 1900), compared with the average for 1907 to 1910, our annual exportations decreased from 210 million to 108 million bushels of wheat, and from 196 million to only 49 million bushels of corn. (These are not estimates, but facts.) In percentage of total "estimated" production, the corn exports decreased from 10 per cent. to 2 per cent., and wheat exports decreased from 37 per cent. of our production for 1897 to 1900, to only 16 per cent. of the production for 1907 to 1910.

THE GREATEST DECEPTION

And yet, if we ignore the census facts, and accept only the "estimates" of the Department of Agriculture, a comparison of averages of the "statistics" for these two four-year periods would show that, after deducting the actual exportations, our average annual supply for domestic consumption increased during the decade from 359 million to 575 million bushels of wheat, and from 1,806 million to 2,741 million bushels of corn; or, in other figures, these four-year averages would show that our supply of wheat for bread increased during the decade by 60 per cent., and that our domestic supply of corn for the production of meat, etc., increased by 52 per cent.; whereas, our population increased by only 21 per cent. during the same decade.

Thus the only real basis for the common complaint of the people regarding the food supply is that they can not live on "statistical" fiction.

In his annual report for 1912, Secretary Wilson makes the following generous statement:

> The great and growing movement carried on by the department for agricultural betterment has not been sustained solely by one man.

It must also be recognized that the faults

of the department, including the condemnable inflation of crop "statistics," and the wide promulgation of erroneous theories, such as have emanated from the Bureau of Soils, advocating doctrines which can lead only to land ruin, are not all to be set down as the sins of one man. There have been in the service of the United States Department of Agriculture, some of the most eminent scientists the world affords, and other conscientious public servants, including, unquestionably, many of the field agents; and so have there been others whose public "service" is far worse than worthless.

Cyril G. Hopkins
University of Illinois

THE AMERICAN PHILOSOPHICAL SOCIETY AND PRESIDENT WILSON

On Wednesday of last week a committee of the American Philosophical Society consisting of President W. W. Keen, Hon. Charlemagne Tower, Hon. Elihu Root, Secretary Charles D. Walcott, of the Smithsonian Institution, President Robert S. Woodward, of the Carnegie Institution, and Director Otto H. Littmann, of the U. S. Coast and Geodetic Survey, were received by President Wilson, by special appointment in the east room of the White House, and presented to him, on behalf of the society, the following congratulatory address on his accession to the presidency.

To His Excellency Woodrow Wilson, President of the United States:

Sir: The American Philosophical Society extends its cordial congratulations to you, as one of its fellow-members, upon your accession to the presidency of the United States. You carry into public life the ideals of the scholar; and you will show in the New World, as has been proved so often in the Old, that philosophical training, in the best and broadest sense of the term, is a help to the practical statesman. Your studies in history and in political science will illuminate your task of giving to the nation a wise and strong government.

It was Montesquieu, the good genius of the makers of our national constitution, who said that for a safe voyage for the ship of state the spirit of the laws should serve as compass and history should be the chart. This society confidently believes that you have at your command this compass and this chart; that with your firm hand at the helm the ship of state will safely ride the seas; and that you, like those of your distinguished predecessors in the presidency who were its members, will help to make the future history of the nation worthy of its past.

Seven times since the founding of the Republic the American Philosophical Society has had cause for congratulation in the selection of one of its members as President of the United States. Washington, Adams, Jefferson, Madison, the second Adams, Buchanan and Grant were honored names upon its roll before the popular vote inscribed them in the list of American Presidents. To you, the eighth in turn of its members to enter upon this high office, this Society extends its warmest greeting.

Given under the seal and in the name of The American Philosophical Society held at Philadelphia for Promoting Useful Knowledge this seventh day of March, 1913.

W. W. Keen,
President
I. Minis Hays,
Arthur W. Goodspeed,
Amos P. Brown,
Harry F. Keller,
Secretaries

The president thanked the committee for the presentation of the address and later he made a more formal acknowledgment as follows:

The White House, Washington,
March 19, 1913.

My Dear Dr. Keen: May I not express to you, and through you to the members of the American Philosophical Society, my deep and sincere appreciation of the cordial message brought me from the society by you and your associates this afternoon?

Nothing has gratified me more. I do not know of any association whose confidence I would rather enjoy. It has been a matter of peculiar pride to me to be associated with the American Philosophical Society, and that that distinguished body should feel honored by my elevation to the Presidency is a source of genuine satisfaction to me. I can only say in reply to their gracious address that I shall hope and strive at all times to deserve their respect and confidence.

Cordially and sincerely yours,
Woodrow Wilson.

Dr. William Keen,
Philadelphia, Pa.

SCIENTIFIC NOTES AND NEWS

IT is announced that Dr. H. B. Fine, professor of mathematics in Princeton University, has been offered by President Wilson the ambassadorship to Germany.

DR. DAVID F. HOUSTON, secretary of agriculture, will retain the chancellorship of Washington University on leave of absence. Professor F. A. Hall, dean of the college, has been appointed acting chancellor.

PROFESSOR WILLIS LUTHER MOORE, who has been chief of the United States Weather Bureau since 1895, will retire from this office on July 31.

DR. ELIE METCHNIKOFF, assistant director of the Institute Pasteur, Paris, has declined the directorship of the Institute of Experimental Medicine at St. Petersburg, vacant by the death of Dr. B. Podvyssotzky.

THE ministry of public instruction of the French government has selected Dr. Maxime Bôcher, professor of mathematics in Harvard University, as exchange professor for 1913–14. His term of service will fall in the winter semester and will be spent at the University of Paris.

PRESIDENT DAVID STARR JORDAN, of Stanford University, has leave of absence to go to Europe in the interest of the peace movement.

PROFESSOR ARTHUR SCHUSTER, F.R.S., has been elected president of the Physical Society, London.

PROFESSOR W. M. DAVIS, of Harvard University, has been elected honorary member of the Hungarian Geographical Society at Buda-Pest, and foreign member of the Swedish Anthropological and Geographical Society at Stockholm.

ON March 1 there was given in New York City, at Delmonico's, a dinner to Professor Russell H. Chittenden, director of the Sheffield Scientific School of Yale University, by his former pupils and a few other friends. Nearly one hundred were present, there being representatives of almost every Yale class from 1874 to 1908. Dr. Frank S. Meara, '90, acted as toastmaster and addresses were given by Dr. John A. Hartwell, '89 S., chairman of the committee having the dinner in charge; Professor Graham Lusk, '96 Hon.; Professor Henry H. Donaldson, '79; Professor W. T. Sedgwick, '77 S.; Professor Harvey Cushing, '91; Dr. Elliott P. Joslin, '90 and '91 S.; Dr. P. A. Levene, and Professor Chittenden. At the close of the speaking, Dr. Meara announced that the National Institute of Social Sciences had voted a medal to Professor Chittenden in recognition of the distinction he has attained in original investigation in the field of physiological chemistry. Dr. H. Hollbrook Curtis, '77 S., secretary of the institute, made the presentation. Professor Mendel then presented to Professor Chittenden a set of engrossed resolutions which had been adopted by his fellow members of the board of trustees of the Sheffield Scientific School. It was announced by the committee, through its chairman, that Professor Chittenden's pupils were desirous of expressing their appreciation of his work in some such way that it might have a permanent value, and that to this end there was being raised the Russell H. Chittenden Fund, the income from which should be expended for the benefit of the department of physiological chemistry in the Sheffield Scientific School.

ON March 25, 1914, Geh. Ober-Regierungsrat Professor Dr. A. Engler, professor of botany in the University of Berlin, director of the Royal Botanic Garden and Museum at Berlin-Dahlem, member of the Academy of Science of Berlin, will celebrate his seventieth birthday. In order to commemorate this occasion, his friends in Germany and throughout the world have issued a circular letter requesting that subscriptions toward a marble bust be sent to Professor Dr. Wittmack, Berlin, N. W. 40, Platz von dem neuen Tor 1. The bust will be made by Herrn Bildhauer Manthe, of Schmargendorf.

PROFESSOR RALPH HOAGLAND, head of the division of chemistry of the College of Agriculture, University of Minnesota, has resigned and gone to Washington, D. C., where he will enter on his work in the Bureau of Animal Husbandry.

H. B. Humphrey, formerly head of the department of botany in the State College of Washington, has been appointed to fill the position of pathologist in charge of cereal disease investigations in the Bureau of Plant Industry of the Department of Agriculture.

Professor E. O. Jordan, of the department of pathology and bacteriology in the University of Chicago, has accepted an invitation to become a member of the national commission for the determination of a standard of purity for drinking water. This commission has been formed in connection with the enforcement of regulations relative to pure drinking water, and its object is to establish a federal standard which shall be generally applicable.

Professor George D. Strayer, of Columbia University, has been appointed chairman of a committee of fifteen of the National Council of Education to report on standards and tests of educational efficiency.

Donald F. MacDonald, geologist of the Isthmian Canal Commission, left Panama on March 11 for a month or more of geological exploration in the interior of Panama. The work will be carried on under the auspices of the Smithsonian Institution.

Mr. Vilhjalmur Stefansson lectured before the members of the Royal Geographical Society on March 10 on "The Arctic Islands and their Eskimo Inhabitants." Mr. Stefansson, as has been announced, is at the head of a scientific expedition which will start from Victoria, British Columbia, in June, to explore the Arctic shores of Canada and to make further studies of the Eskimos of Victoria Island on behalf of the Canadian government.

Professor Charles Richmond Henderson, head of the department of practical sociology in the University of Chicago, who has been the Barrows lecturer for six months in the chief cities of India, China and Japan, will resume his regular work at the university near the opening of the spring quarter. The Barrows lectureship, which was established by Mrs. Caroline E. Haskell, provides for a series of lectures in the orient every three years on the general subject of the relations of Christianity to other religions.

On March 8 Professor S. F. Acree, of Johns Hopkins University, lectured before the chemistry department of Princeton University on "The Reactions of Both the Ions and the Non-ionized Forms of Electrolytes."

On March 12 Professor Hugo Münsterberg delivered a lecture at Johns Hopkins University on "Psychology of Labor."

Mr. Frank P. Stockbridge, editor of *Popular Mechanics*, will give a series of weekly lectures on journalism to the students of the course in journalism at the University of Wisconsin this spring.

A course of four public lectures on the theory of the solid state, has been delivered at University College, London, by Professor W. Nernst, director of the Institute of Physical Chemistry in the University of Berlin.

A number of friends, colleagues and pupils of the late Paul Segond have planned a memorial fund in honor of the memory of the surgeon. The income will be used to help internes approved by the council of the Faculté de médecine at Paris to pursue research work and to prepare for their examinations.

It has been decided to perpetuate the memory of the late Alderman C. G. Beale, vice-chancellor of Birmingham University, by (1) the endowment or partial endowment of a chair in the university to be selected hereafter by the university council, and to be called the Beale chair; and (2) a collection of British birds and their nests, mounted in their natural surroundings, to be placed in cases in the first room of the future Birmingham Natural History Museum. Sir Charles Holcroft has promised a donation of £5,000, to be devoted to the endowment of the university chair and there are other gifts amounting to £4,000.

In November last a meeting of old students and friends of the late Professor Tait was held in the physical laboratory of the University of Edinburgh, Principal Sir William Turner presiding, when a committee was appointed to establish a memorial. The com-

mittee has now decided to recommend the raising of a fund of from £20,000 to £25,000, for the purpose of endowing a second professorship of natural philosophy in the university. The proposed chair would be connected with the department of Professor Tait's work in which he achieved especially conspicuous success, namely, the application of mathematics to the solution of physical problems, including those which bear upon engineering and other departments of applied science; and the committee feel sure such a chair would not only form an appropriate and worthy memorial, but would also be in itself of the highest utility. The committee are making every effort to bring the project to the attention of all old students, both at home and abroad, and they are confident of getting into communication with over 6,000 of them. They feel justified, however, in appealing not to old students merely, but also to men who were associated with the professor in any department of his work; to natural philosophers, mathematicians and scientific men generally, who through their study of his publications have become indebted to him as a teacher; to those who are interested in the progress of the Scottish universities, and recognize the great value of his services to education; and to such of his fellow citizens as take pride in his scientific eminence and recall with interest his picturesque personality. The hon. secretary, Professor J. G. MacGregor, the University, Edinburgh, will be glad to furnish any information that may be desired, either by letter or, in cases in which it may be possible, by personal interview. Subscriptions should be sent to the honorary treasurer, Sir George M. Paul, 16 St. Andrew Square, Edinburgh.

A MEMORIAL to the late Sir J. D. Hooker, which has been placed in the parish church at Kew, near the similar memorial to his father, Sir W. J. Hooker, was unveiled by Lady Hooker on February 22. It consists of a mural tablet of colored marble bearing an inscription, below which is a Wedgwood medallion portrait of Sir Joseph, flanked and supported by five panels containing Wedgwood figures of plants with which there had grown up some especial association.

THE death is announced, at the age of ninety-one, of Major-General Henry Clark, who was elected a fellow of the Royal Society so long ago as 1848. He was the author of papers on the strength of timber, and the flow of liquids through small orifices and other subjects.

DR. RUDOLPH FRANK, professor of surgery at Vienna, has died at the age of fifty years.

IT is stated in *Nature* that Mr. R. J. Balston, of Maidstone, has presented to the British Museum (Natural History) his well-known collection of humming-birds. The birds are mounted and arranged in forty-nine cases, each of which contains a group of two or more species. The total number of specimens in the collection is stated in Mr. Balston's manuscript to be 3,315, representing 162 genera and 480 species. Of these, 2,674 are skins, and 199 nests, some of the latter containing eggs. As soon as arrangements are made for its reception the series will be placed on exhibition in one of the corridors on the first floor of the zoological department. This collection and the Gould collection will render the exhibited series of humming-birds one of the finest, if not actually the finest, in the world.

THE Peabody Museum of American Archeology and Ethnology of Harvard University, has recently received two important acquisitions. The first is a valuable collection of prehistoric pottery from the mounds of the Red River region, Arkansas. This pottery, which is the gift of Mr. Clarence B. Moore, '73, of Philadelphia, Pa., came to the museum in several hundred fragments. They have now been cemented together and added to the regular exhibit. The other acquisition is a large collection of stone implements from the Island of Grenado, W. I., the gift of Dr. Thomas Barbour, '06.

A WEEKLY journal entitled *Die Geisteswissenschaften* has been established under the editorship of Dr. Otto Buek, of Berlin, and of Professor Paul Herre, of Leipzig, published at Leipzig by Veit and Co. The scope of the journal includes philosophy, psychology, mathematics, religion, history, philology, art,

law, sociology and education. The announcement states that the journal undertakes "für das Gebiet der Geisteswissenschaften ein ähnliches Programm verwirklichen, wie ihm für die Naturwissenschaften in England die 'Nature,' in Amerika die 'Science,' in Deutschland 'Die Naturwissenschaften' nachstreben."

We learn from *Nature* that the will of the late Mr. Rowland Ward, the taxidermist, directs that the trustees with respect to his charitable bequests shall expend 500*l.* per annum out of the income of his residuary estate, after the legacies and annuities specified have been paid, for a period of ten years in the purchase of specimens to be presented to the Natural History Museum, South Kensington. The residue of his estate is left in equal shares to such eight of fourteen selected charitable and other institutions as his widow shall choose. In default of his widow's selection within twelve months of the testator's decease, the whole of the fourteen institutions —which include the Natural History Museum —are to share equally.

The only public standardizing and testing laboratory for public utilities and industries generally, outside of the one maintained by the Bureau of Standards at Washington, has just been established by the regents of the University of Wisconsin, in cooperation with the Wisconsin Railroad Rate Commission. The purpose of the university's new laboratory is to render more direct service to public utilities and to industries of the state by supplying them at a reasonable cost with the opportunity to have meters and similar instruments scientifically tested. Hitherto the smaller public utilities and industries that could not afford to maintain testing laboratories of their own have been compelled to have their testing done as favors by a few large companies that could maintain testing laboratories.

The following lectures are being given at the University of Minnesota:

January 17—"Eugenics and Race Betterment," Dr. Victor C. Vaughan, dean of the department of medicine and surgery, University of Michigan.

January 28—"Cancer and its Prevention," Dr. L. B. Wilson, of the Mayo Hospitals, Rochester, Minnesota.

February 11—"Heredity and Environment," Dr. E. L. Tuohy of Duluth.

February 25—"The Nature of Disease," Dr. W. T. Councilman, professor of pathologic anatomy, Harvard Medical School.

March 11—"Public Health a Public Duty," Dr. Mazyck P. Ravenel, professor of bacteriology, University of Wisconsin, and director of the Wisconsin State Hygienic Laboratory.

April 1—"The People's Responsibility in Dealing with Public Health Problems," Dr. H. M. Bracken, executive officer, Minnesota State Board of Health.

April 15—"The Need for an Efficient National Health Service in the United States from an Economic Standpoint," Dr. John B. Murphy, professor of surgery, Northwestern University Medical School.

April 29—"The Profession of Medicine; an Agency in Social Service," Dr. Richard Olding Beard, professor of physiology, University of Minnesota.

May 6—"The Growth of Hygienic Ideals," Dr. Henry B. Favill, professor of medicine, Rush Medical College.

The United States Bureau of Education has just published a *Bibliography of the Teaching of Mathematics*, covering the period from 1900 to 1912, by David Eugene Smith and Charles Goldziher. This bulletin gives 1,849 titles of books and articles on the teaching of mathematics that have appeared since 1900. The bulletin will be sent free upon application to the United States Commissioner of Education, Washington, D. C.

We learn from the London *Times* that an arrangement has been made for cooperation between the British board of trade and the principal Atlantic steamship lines in carrying out during the present year the recommendations of the merchant shipping advisory committee in their report on life saving at sea with respect to stationing a vessel for ice observation to the north of the steamship routes across the North Atlantic. In accordance with the advice of a special conference summoned by the board of trade to consider the best means of giving effect to this recom-

mendation, it is proposed that a vessel should be stationed off the east coast of North America to the north of the steamship routes during the coming spring to watch the break-up of the ice and to report its movement on the way to the routes. The *Scotia*, a whaler, formerly employed in the Scottish Antarctic Expedition, has been chartered to carry out this work, and it is anticipated that she will be ready to leave Dundee, where she is at present lying, about the end of this month. The vessel is being fitted with a Marconi wireless installation having a long range, so that she will be able to keep in touch with the wireless stations in Newfoundland and Labrador. The cost of the expedition will be shared between his majesty's government and the principal Atlantic steamship lines. In order to make the necessary observations in connection with the movement of the ice, there will be three scientific observers in the *Scotia*. As the vessel will from time to time be stationary, it is expected that these observers will be able to make oceanographical and meteorological observations as to currents, etc., which will be of general scientific interest, as well as of direct value to the work in hand. The *Scotia* is a wooden barque of 357 tons, built at Drammen in 1872, and is fitted with an auxiliary steam engine.

EIGHT trains sent out to all parts of Wisconsin by the College of Agriculture of the University of Wisconsin to demonstrate better farming methods reached 32,275 people, according to the report of the men in charge of the trains. These trains traveled about the state for thirteen weeks stopping every little way to give farmers an opportunity to visit them, and learn how their crops and livestock could be improved. Men from the agricultural college accompanied each train and lectured wherever stops were made. The trains were of three kinds. One kind was devoted to livestock, another to grains, and the third to potatoes. In the livestock trains prize animals were shown together with exhibits illustrating the care and feed of them. Lectures and informal talks on the value of using pure-bred animals and kindred subjects, supplemented the various exhibits. Exhibits illustrating the good results attending the use of high-grade seed grains, how to improve the quality and yield of potatoes, etc., were shown in the grain and potato demonstration trains.

WITH Admirals Bradford and Chester in attendance, Captain J. L. Jayne, superintendent of the U. S. Naval Observatory, inaugurated Monday afternoon, February 10, a system of fortnightly meetings of the scientific staff for the discussion of topics relating to the work of the observatory. Professors Skinner and Frisby, now retired, but formerly for many years actively engaged in the work of the observatory, also took part in the proceedings. The paper of the afternoon, by Dr. W. D. Horigan, librarian, on "The Founding of the Observatory," detailed the meager progress of astronomy in this country during the eighteenth and the early part of the nineteenth centuries, and traced the efforts of various learned men and statesmen to establish a national astronomical observatory, up to the crowning of their efforts in the founding of the U. S. Naval Observatory in 1842. For the bringing about of this event the scientific world is directly indebted to Lieutenant J. M. Gilliss, U. S. Navy. In the discussion following the paper, Admiral Chester, formerly head of the observatory, stated that the paper should be printed in order that astronomers the country over should benefit by the thorough researches of the author.

ACCORDING to the *Journal* of the American Medical Association the American Telephone and Telegraph Company, the Western Union Telegraph Company and the Western Electric Company have made public a comprehensive plan for the payment of sick benefits and life insurance for their 175,000 employees. It is said that $10,000,000 is available for this purpose. In connection with this pension plan there is to be gradually established a system of medical supervision and preventive sanitation designed to preserve the health of employees. The preventive measures will not only include early detection of disease among

employees, but also a supervision of sanitary conditions in offices and workshops and the instruction of employees in hygiene. The plan does not necessarily propose to furnish medical attendance to employees, but it will aid them in securing prompt and efficient treatment. Arrangements will be made with hospitals throughout the country for the prompt reception of those who seek this kind of treatment. It is believed by the companies that this plan will be an economical advantage to both parties. Dr. Alvah H. Doty, formerly health officer of the port of New York, has been appointed director of this department.

With a view of elucidating the history of native cotton, Mr. Frederick L. Lewton, of the U. S. National Museum, has written a pamphlet entitled "The Cotton of the Hopi Indians: A New Species of *Gossypium*," forming publication No. 2,146 of the Smithsonian Miscellaneous Collections. The fact that cotton was used and of necessity cultivated by the Indians, is recorded by several early Spanish explorers, as it has been more recently by many ethnologists. In the villages of the cliff-dwellers of Mesa Verde National Park numerous fragments of cotton cloth have been unearthed, and, in Utah, the seeds of the plant itself have been found. To-day, among the Hopi Indians of Arizona, the cotton plant is highly esteemed, and its fiber enters into many of their ceremonies, as well as into many practical household activities. It is considered essential by them that all strings employed in religious services be of native cotton. These strings of cotton are used to bind together prayer sticks and offerings of all kinds, and are placed in the trails entering the pueblos where ceremonial services are in progress; the badges of the chiefs are all wrapped with native rough-spun cotton strings; and cotton is also used to weave ceremonial kilts, belts and wedding blankets. Unfortunately the native Hopis, once deft in the art of weaving blankets, mantles, rugs and other articles from cotton, now find it far easier to purchase either the yarn already spun, the cloth already woven, or the complete garment, and thus the art is gradually being lost. Cotton is still cultivated by them, however, to a small extent, in a village in the western Navajo Reservation and in another of the Moqui. The Department of Agriculture has carried on experiments with Hopi cotton for the past seven years. This particular species of cotton is remarkable in the rapidity with which it grows and the early date at which it blooms, it being the earliest to blossom of several hundred species put to test. Plants of this species have borne ripened bolls in eighty-four days from the sowing of the seed. Following a pertinent discussion as to the history and development of this particular sort of cotton, Mr. Lewton describes botanically the distinguishing features of a new species which he calls *Gossypium hopi*, and which is illustrated by five plates showing the growing plants, the flowers and the maturing and ripe bolls.

How the county "poor" farms of Wisconsin are being utilized to convince farmers of the advantages of up-to-date methods of agriculture, is explained by F. B. Morrison, assistant to Dean H. L. Russell, of the University of Wisconsin College of Agriculture, in the current number of the university's alumni magazine. In 1909 the college of agriculture instituted field demonstrations on several "poor" farms. The most approved methods of agriculture are put into practise on these fields so that the farmers of the surrounding country can see for themselves the results of simple improvements over their own methods. Each county farm is also made the center for distribution of pure-bred seed grain, bred scientifically at the college of agriculture. The demonstration fields are located on main traveled roads so that farmers passing by may see the results during the entire growing season. Farmers are always welcome at the demonstration fields and are encouraged to ask as many questions as possible. When the demonstration crops are at their best an annual demonstration picnic is held to which all the surrounding farmers and their families are invited. Sometime during the day of the

picnic all the participants are taken out to the demonstration fields and there the methods used to secure high yields are explained by professors from the agricultural college. How popular these meetings are is shown by their growth in attendance. In 1909 the average number present at a meeting was 80; this year it was 450. A notable result of these demonstration fields and demonstration picnics is the great improvement in agricultural methods in the sections where they are in force.

UNIVERSITY AND EDUCATIONAL NEWS

THE London correspondent of the *Journal* of the American Medical Association writes that the British government has made arrangements for taking part in the tropical diseases exhibition to be held at Ghent this year. The London School of Tropical Medicine, the Liverpool School of Tropical Medicine, the Cairo and Khartum schools, the navy and the army will be represented. Each of these organization has been given certain diseases to illustrate in a popular manner, so that people may realize what is being done to make the tropics habitable to mankind. The cases will contain specimens of the insect pests which are the cause of the spread of disease in the tropics, with examples of the culture of bacteria taken from their blood, and numerous microscopic and photographic views of the development of the different stages. In all, thirteen diseases will be illustrated. The London School of Tropical Medicine will make a complete display of the work in progress in connection with cholera, beriberi and elephantiasis, including any fresh information available consequent on the outbreak of cholera among the Balkan troops. The Liverpool school will set out the work that is being carried on against yellow fever and sleeping sickness, diseases in which the school has specialized for a long time. The admiralty will exhibit what has been done by the fleet surgeons in the matter of undulant fever, more commonly known as Malta fever, and due to the goats of the island. The war office will take up that scourge of all armies, typhoid fever, and will depict the results of the study in the prevention and cure of the disease. Plague comes under the direction of the India office, and Dr. Andrew Balfour, of the Egyptian service, will make a special exhibit dealing with leprosy and other eastern diseases. Most, if not all, of the exhibits will make an important feature of the part played by flies, mosquitoes, fleas and rats in the distribution of disease. Part of the display is intended to inform the public how best to guard against these insect pests. Mosquito-proof houses, mosquito-proof clothing, and even mosquito-proof books are to be on view. A rat-proof house will be included in the departmental exhibits. There will be several examples of foods which have been deprived of their nutritive qualities, such as polished rice, which causes beriberi. The Liverpool school, which deals with this subject, will exhibit tinned foods from which the nutritive properties have been withdrawn in the process of preserving.

THE Arkansas general assembly has appropriated $36,000 for the medical department of the University of Arkansas for the biennial period ending March 31, 1915.

LAKE ERIE COLLEGE has obtainel the sum of $200,000 for general endowment.

THE Tucker fund committee at Dartmouth College has established a fellowship of the value of $1,200 which may be renewed for a period of three years; the holder of the fellowship may study at an American or foreign university and at its expiration must be prepared to accept an instructorship at Dartmouth College.

DR. CHARLES F. MYERS, of New York City, has bequeathed $25,000 to Acadia University, Nova Scotia, to establish a professorship of biology.

MR. AUGUSTUS NASH has bequeathed the residue of his estate in trust to pay a near relative the income during life, and afterwards to pay the capital sum to Bristol University in the hope that it may be used to ad-

vance natural sciences, particularly chemistry. The sum will be about £18,000.

The four largest courses in Harvard College last year were government 1 with 479 undergraduates, economics 1 with 438, philosophy E (elementary psychology) with 373, and chemistry 1 with 333. The other two courses which had over 200 undergraduates were philosophy A, Professor Palmer's course on the Greek philosophy, with 272, and history 1 with 250.

The vice-chancellor of the University of Cambridge has appointed April 19 for the election to the Plumian professorship of astronomy and experimental philosophy, vacant by the death of Sir George Darwin. Candidates are requested to send their names to the vice-chancellor on or before April 11.

Professor Henkel, of Königsberg, has been appointed director of the institute of pathology at Breslau, as successor to Professor Ponfick.

Professor Hoffman, of Prague, has been appointed to succeed Professor L. Hermann as director of the institute of physiology at Königsberg.

DISCUSSION AND CORRESPONDENCE

A SIMPLE FORMULA FOR COMPUTING GYROSCOPIC FORCES IN AN AEROPLANE

The recent letter of Mr. James Means, in Science for December 13, 1912, has called renewed attention to the problem of the gyroscopic action of a revolving motor as affecting the safety of an aeroplane. The following simple formula for computing the magnitude of this gyroscopic action is offered as a contribution toward the symposium suggested by Mr. Means.

We shall regard the rotating motor as consisting essentially of a single wheel or disc, whose axle is supported by two bearings at known distances from the center of the wheel.

If the aeroplane is compelled by the rudder, or by a sudden gust of wind, to change its direction of flight, this compulsion may be thought of as due to the pressure of a flat board against the side of the axle, at a point, say, in front of the wheel. As is well known, the axle will resist this pressure on account of the gyroscopic action of the rotating wheel, and will *strive to move off at right angles to the impressed force*, and in so doing, will *strive to carry the whole aeroplane with it*. If the wing surface of the aeroplane is large, this motion will be practically entirely prevented by the resistance of the air, and the result of the gyroscopic action will be the setting up of *internal stresses* in the framework of the machine.

The object of the following formula is to provide a simple means of computing the maximum value of these internal stresses in any given case.

Let $a =$ the distance between the bearings, measured along the axle, in *feet*, and let $P =$ the pressure, due to gyroscopic action, on each bearing, in *pounds*. Then P is given by the following formula:

$$Pa = (0.00034 \cdots) W r^2 N n,$$

where

$W =$ weight of the rotating wheel, in *pounds*,

$N =$ angular velocity of the rotating motor, in *revolutions per minute*,

$n =$ the angular velocity with which the aeroplane is turning out of its path, measured in *revolutions per minute*, and

$r =$ the radius of gyration of the wheel about its axle, in *feet*.

Note 1.—A fair estimate of the radius of gyration can be obtained by a mere inspection of the linear dimensions of the wheel. For example, if the wheel were a homogeneous disc of radius R, then $r = (0.7)R$, approximately; while if all the material were concentrated in the rim, then $r = R$; intermediate cases can be judged by the eye.

Note 2.—The coefficient $0.00034 \cdots$ represents the value of $\pi^2/900g$, where $g = 32$ ft. per sec. per sec. If the lengths r and a are measured in *centimeters* instead of in feet, this coefficient must be replaced by $0.0000112 \cdots$. If r and a are measured in *inches*, the coefficient is $0.000029 \cdots$.

As an illustrative numerical case, suppose $W = 167$ lbs. (which is the actual weight of a fifty-horse power Gnome motor), $N = 1{,}200$

revolutions per minute, $n=5$ revolutions per minute (estimated), and $r=2/3$ ft. (estimated). Then if $a=1$ foot, we shall have $P=$ about 150 lbs.; or, if $a=2$ ft., $P=75$ lbs., etc.

It thus appears that under ordinary conditions of flight, the effect of these gyroscopic forces could hardly be serious.

In conclusion, we note the following simple rule for determining the *direction* in which the force P will be exerted. (This rule was first published by the writer in the *Engineering News* for June 21, 1910. See also *The Scientific American* for November 23, 1912.)

Imagine the deflecting force (that is, the force which compels the aeroplane to change its direction of flight) to be due to the pressure of a flat board against the spinning axle (say in front of the motor), and *note the direction in which the axle, if rough, would tend to roll along the board;* this will give the direction in which the (forward) end of the axle will tend to move as the result of gyroscopic action—that is, the direction in which the force P will act against the (forward) bearing.

For example, suppose the axle is spinning in the clockwise direction, as seen by an observer looking forward, and let the aeroplane make a sharp turn to the *left;* then the forward end of the axle will strive to *rise.* Similarly, if the aeroplane makes a sharp dive *downward,* the forward end of the axle will strive to turn to the *left.*

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FUR-BEARING MAMMALS: AN UNAPPRECIATED NATURAL RESOURCE

The manor of living nature is so ample, that all may be allowed to sport on it freely; the most jealous proprietor can not entertain any apprehension that the game will be exhausted, or even perceptibly thinned.

In such wise did Dr. Richard Harlam, writing in 1825, comment on the inexhaustibility of our natural game resources. As late as 1857 the following in substance appears in the report of an Ohio state senate committee:

The passenger pigeon needs no protection. Wonderfully prolific, having the vast forests of the north as its breeding grounds, traveling hundreds of miles in search of food, it is here to-day and elsewhere to-morrow, and no ordinary destruction can lessen its numbers, nor can those killed be missed from the myriads that are yearly produced!

The tragic story of the passenger pigeon is familiar to every one. Not so familiar, perhaps, are similar stories which may be told of other species. Fortunately, there is a growing realization that our national resources in wild life are rapidly dwindling, and attention is being directed toward checking the extermination.

This consideration comes not a moment too soon. Unless protective laws are enacted before a species is nearly extinct they can not ordinarily avail much. Nevertheless, vigorous efforts should be made continually not only to conserve species which are still plentiful, but to preserve species which, through our lack of foresight, are on the verge of extinction.

There is, however, one department of our fauna which, in the opinion of the writer, has hardly received its deserved quota of attention. I refer to the several species of fur-bearing mammals whose pelts have a commercial value. The species concerned include the bear, raccoon, skunk, badger, otter, sea otter, mink, marten, fisher, red fox and wolverine.

It is estimated on fair authority that there are within California alone trappers in the proportion of ten to the county, each of whom makes a possible average of five hundred dollars from his annual catch. There are fifty-seven counties, so that five hundred and seventy persons with a total income for the fur season of $285,000 a year would on this estimate be resident in the state. Two hundred and eighty-five thousand dollars is the interest at four per cent. on $7,125,000. This, or even a quarter of it, would seem to be enough of a commercial asset to be worth at least some legislative consideration.

On the basis of figures quoted by Ernest Thompson Seton[1] it appears that an extremely

[1] "Life Histories of Northern Animals," 1909.

conservative estimate would place the revenue to North America as a whole for the last seventy-five years from the furs of the raccoon, badger, wolverine, fisher, marten, mink, otter, red fox and large striped skunk at $222,735,000, and to the United States at $113,950,000. This is an average value per year of a little less than $3,000,000 to North America as a whole, and $1,500,000 to the United States. Three million dollars is the interest at four per cent, on $75,000,000 and $1,500,000 is the interest at four per cent. on $37,500,000.

Thus a conservative estimate shows that $37,500,000 is the "capital invested" by the United States in the fur-bearing mammals listed. These figures, while not especially large, do indicate that the fur value of these species has been appreciable! It should be remembered, too, that the furs of such damage-doing species as bear, coyote, wolf, mountain lion, lynx and wild cat are not listed in this estimate. That the fur trade total would be considerably swelled by the inclusion of the last-named mammals is indicated by the fact that Brass[8] has shown that the *annual* value of all North American furs during the years 1907–09 averaged one hundred million marks, or about $25,000,000. My estimates given above are probably below the actual figures even for the species included. Twenty-five million dollars is the interest at four per cent. on $625,000,000, which represents the approximate money-value of all North American fur-bearing mammals.

It is clearly apparent that there are good economic reasons for the protection of some of our mammals at least. The need of conservation is beginning to be keenly felt in California, where trappers in the Sacramento Valley recently testified to the writer that practically all fur-bearing species are rapidly decreasing. There is much wanton destruction of these animals during the summer season when their fur is worthless. The grizzly bear, the noblest member of our California fauna, is now practically extinct. The sea-otter, possessing the highest fur value of all our mammals, formerly existed in great numbers off the coast of western America, and is also a vanishing species. The dismal story of dwindling numbers and final extinction seems about to be repeated in the cases of certain animals with which we are now dealing as though the "manor of living nature" was inexhaustible.

We are confronted with two facts: first, America's crop of fur is economically profitable, and second, the mammals on which this harvest depends are in most cases decreasing in numbers. We may dispose of these mammals in one of two ways: (*a*) They may be appropriated to man's use as rapidly as possible, with no thought of future supply. Their money-value thus becomes a perfectly definite sum, which can not be added to when the species become extinct. (*b*) They may be wisely conserved, heed being paid to the future. Their economic value under this method would either remain at about the figure at which it now stands, or would increase, and the fur-bearing mammals would be of permanent instead of transitory worth in dollars and cents. For instance, in California we could count on a quarter of a millon dollars coming into the state annually which would not otherwise find its way here.

Upon proposing legislation it becomes immediately apparent that there are difficulties. Several of the animals mentioned are charged with various offences against the farmer. Others are to some extent predatory on game fishes and game birds. There is strong suspicion in the minds of some that their depredations are in many cases not so serious as certain of the indictments against them would indicate. But the lack of information does pointedly emphasize the need for more data as to their numbers and habits.

Nature-history museums may be relied upon for some of these desiderata, but at best there is no doubt that our knowledge is yet fragmentary and inconclusive. A state trapper's license, be it ever so small, would give data as to numbers of trappers and amount of trapping done which would be invaluable to legislators desiring to adopt a wise conservation policy. Perhaps more important

[8] "Aus dem Reiche der Pelze," 1911, p. 356.

even than this would be a thorough investigation by the various state and provincial game or conservation commissions of the habits of the species concerned, with special reference to food preferences and commercial values.

Protection of those species whose numbers are not yet reduced below a critical point would doubtless be possible and adequate. Conservation of beavers has been successful in such cases. Nature distinctly favors some of the species through their practically inaccessible habitats, or their self-protective instincts. It is evident that protective legislation would consequently vary with the species and with the conditions of its existence in particular localities. Where one mammal may require a five-year closed season, another may need protection during the breeding season only, and for still another, protection may be altogether unnecessary at present.

There is further reason for paying heed to these elements of our fauna. The fact that man is the dominant species does not justify his wanton extermination of any members of the living world around him. It has taken nature geologic ages to evolve these animals, and it is our duty to be considerate in our dealings with subordinate forms of life.

> There is no resurrection or recovery of an extinct species, and it is not merely that here and there one species out of many is threatened, but that whole genera, families and orders are in danger.

Dr. Mitchell in a recent number of SCIENCE[8] has forcibly called attention to a number of facts, full of sinister warning to those who dislike to stand by and see the careless destruction of our native fauna. Allow me to quote again for the sake of emphasis:

> Each generation is the guardian of the existing resources of the world; it has come into a great inheritance, but only as a trustee.

In the opinion of the writer the intrinsic interest and the humanitarian arguments, as well as the economic one, emphasize strongly the desirability for wise attention to this lesser problem of the fur-bearing mammals, none the less than to the careful conservation of all the rest of the wild life yet remaining at our disposal.

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[8] 1912, p. 353 and following.

THE WRITINGS OF WILLIAM G. SUMNER

TO THE EDITOR OF SCIENCE: A little over a year ago the Yale University Press published a collection of essays by the late Professor William Graham Sumner. It is now proposed to publish another volume to be called "Earth Hunger and Other Essays," during the fall of 1913 or a little later. In connection with this enterprise, I wish, as editor, to bespeak your assistance.

It is desired, in this proposed volume, to collect (aside from more extended matter) all of Professor Sumner's shorter publications. Many of his best and most characteristic utterances were brief articles, struck off on occasion, and widely scattered in newspapers and magazines. We have little trouble in finding his longer articles, but it is difficult to locate many a short and vivid fragment. Since the other volume was issued, not a few suggestions have come to our ears to the effect that another time we should not overlook this or that pregnant utterance—some striking thing which has riveted the attention of our courteous censor, and which he would like to have at hand. Sometimes such a constructive critic can not remember just where or when he has seen such an article, and suggests vaguely that it was "in the papers," or "in one of the weeklies."

Now we want all these scattered materials, and it has occurred to me that suggestions might be forthcoming as to their whereabouts, if our present effort to make a final and exhaustive collection of Sumneriana were announced to your readers. We should be glad to examine any materials that might come within the scope of the proposed volume, and to receive any suggestions, however vague, as to utterances, brief or extended, from the pen of Professor Sumner. Materials sent me in care of the Yale University Press will be acknowledged and promptly returned after examination.

As this volume will, in all probability, close the collection of Sumner's printed works in the line of essays and short pieces, those who can assist us in securing available materials will confer a substantial favor.

ALBERT G. KELLER

LEST WE FORGET

TO THE EDITOR OF SCIENCE: The new administration, with democratic majorities in both house and senate, was entrusted with power in the belief that it will be responsive to the needs and demands of the people. But in the various programs suggested for the amelioration of present-day abuses nowhere has any mention been made of the early adoption of the metric system as an obligatory system in this country, accompanied by the destruction of the old systems. The writer has reached that second childhood when, at the request of his children for aid in doing their "sums," he must again wade through the chapters in the arithmetic devoted to the various tables of hodge-podge units, and he realizes, as never before, the truth of the statement that the whole thing is "a wickedly brain-destroying piece of bondage under which we suffer."

To see young minds eager for the study of live subjects forced to work hundreds of useless problems in this treadmill of heterogeneous dead and dying units is enough to rouse the ire of any one against those selfish interests which are blocking the way of reform.

When we consider the situation candidly we must acknowledge that the matter is one of extreme importance. A great part of the under-weight and false-measure frauds are directly due to our confused system of units, and on the adoption of the metric system under such protective regulations as are in force in Germany, for example, a tremendous saving would be effected in the cost of living to wage earners especially. Can not all scientists, who understand so well the merits of the metric system, rouse themselves and make a strong effort to have the bill passed which has been before congress for many years, backed by the various government bureaus and reform leagues? It took thirty years to obtain the parcel post; must we wait that long? Or can we not make a long pull, a strong pull, and a pull all together, and get it through next winter?

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TO WHOM IS THE ACADEMIC COSTUME WORTH WHILE?

TO THE EDITOR OF SCIENCE: Even if we disagree on the use of medieval costume in modern institutions as a matter of academic good taste, may we not set our faces against any participation in the decision by a commercial propaganda aiming to extract large profits from members of an underpaid profession?

T.

SCIENTIFIC BOOKS

Cambrian Brachiopoda. By CHARLES D. WALCOTT. Monograph U. S. Geological Survey, Vol. 51. Part I., Text. Part II., Plates. 1912. Pp. 872, 76 text figures, 104 plates.

The dominating impression which this extraordinary work leaves upon one who runs a hasty eye over its pages and luxurious plates, is that of the marvelous industry and enthusiasm of its author. If the paleontological genius who controlled these facts here assembled had nothing else to do, the wonder might be less. But amid the responsibilities of a great office and affairs of widest scientific concern, the writer of this book seems to let no minutes go to waste which can be made to forward his expositions of that field in paleontology of which he has long been the most effective illuminator.

Here are two quarto volumes devoted, by title at least, exclusively to the Brachiopods of the Cambrian fauna. Nearly twenty years ago students of this multitudinous, variant group of animals believed the sum of knowledge concerning them enough to justify a treatise on the broad lines of their generic characters, so Professor James Hall and his assistant published two big quartos on this subject, therein searching out every nook and cranny that might afford traits of generic sig-

nificance in all known or available forms of these creatures. Even to such a study the Cambrian brachiopods cut a very modest figure in paleontology. Specimens were few, their structures were obscure, and hence their relations were difficult to interpret; most of the available material was poorly preserved and, as a whole, they played a dubious rôle in the generic history of the entire class as well as in the total of the Cambrian fauna.

In this new book the student may scan 104 crowded plates of the Cambrian Brachiopods, bearing from 3,000 to 4,000 figures, and after the first bewilderment has passed, he comes to the realization that at last a definite progress has been made in the census, the analysis and estimate of the morphology and biologic worth of these early and hence most significant organisms.

The columns of SCIENCE are hardly the place for a critical study of Dr. Walcott's results or a measurement of their advance over previous knowledge. The author's publications on various aspects of the Cambrian fauna have been as startling as rifle shots and as effective in opening our eyes to the unexpected development of life within this field. With this book before us, inherited and acquired notions of the paucity of life in this "primordial" age of the earth are forever swept aside. The present panorama of the Cambrian Brachiopod fauna is simple in aspect but numerically comparable to the brachiopod element in any later geological age. At any rate here are listed about six hundred species and only the census taker for the class would dare say how far any single subsequent period has overpassed that number. As against their successors in the later rocks they lack in diversity of expression, for these are simple, sturdy, coherent types, largely devoid of the sudden and fugitive variations which accompany the tachygenic, arrested and declining stages in succeeding faunas. The author had the courage, years ago, to break the restraints of geography and politics and to content himself with nothing less than the earth for his field. Above a thousand localities are cited in his lists here and it is the Cambrian terrane of the world which the author has been enabled to reach through many direct and indirect avenues; yet the substantial basis of the work is his own discoveries in regions of his own exploiting.

It is probably not the proper business of a notice of this work to analyze the part it has played in the ecology of the author, but the author is, for the moment, impersonal as is any author who may have achieved so tremendous an addition to the details of scientific fact. These kernels of knowledge are not easy to assimilate, they seem to go hard with even the spiritually minded seeker after all truth, and one may be disposed to wonder if the joy of discovery, the sense of contribution, the rebound of satisfaction which comes with each new determination of fact, is not the great reward in such achievement. But here let us go slowly. If the whole truth were to be known and the real underlying genius of life could be indisputably portrayed, I presume the difference between *Lingulella cuneola* and *Lingulella desiderata* might prove to be as vital in the Grand Plan and to the Sum of Happiness, as the winning or losing of a congressional appropriation for a museum of industry. Nevertheless, no man can be so deeply conscious of the worth of such a work as the man who did it; no one can appreciate so well the broader bearings of such a monumental increase of human knowledge. Fortunately it is not of the sort that has to be applied to meet human expediencies. Hence its glorious justification.

The greater volume of the text of this work is given over to the descriptions of the species, but there are preliminary chapters of broader scope, among them none more suggestive than the analysis of differential shell structures. Following Beecher's broader classification of the brachiopods, based on the characters of the pedicle passage, *Atremata, Neotremata* and *Protremata* (the first and second corresponding to Huxley's *Inarticulata*, and the third to the *Articulata*) the majority of species and genera are *Atremata*, and they, with the *Neotremata*, are as much in excess of the rest here as they are over-

passed by the higher *Protremata* in the later faunas. This is as it should be, for they are diverse expressions of the simplest brachiopod structure. Broadly speaking, regardless of their multitude, the species of the major divisions are all oboloid or linguloid in outline. The disk of the oboloids has been oft repeated in the geological history of the brachiopods, though it has served to mask widely distinct genera; but as for the sharpened *Lingula*-form—it would seem there was a divinity that shaped its end, for it has come down to this day without much change, just enough in fact to let us say that no true *Lingula* existed in Paleozoic time, hard as it might be to prove it. One can not restrain surprise at the beauty of retention of much of this material, the perfection of shell structure, of pallial venation, ovarian and muscular impressions, set forth on the plates by extremely effective mechanical processes of illustration. The quality of this illustration is most admirable, and it would seem that the personal error of portraiture has been here reduced to its lowest terms.

Should one, on cursory examination of this host of newcomers in paleontology, wondering over their relationships, their phylogeny and precedence, venture to whisper to himself of *Orusia eurekensis* or *Otusia utahensis*—who was its father? who was its mother? had it a sister? had it a brother?—these wisely suppressed inquiries are answered on page 317, which graphically sets forth the presumed derivative relations of the genera discussed. This page is exceedingly instructive. Beecher found the brachiopod radicle best expressed in the Cambrian genus *Paterina*, and his proposition still holds pretty well under these later studies. Walcott's radicle is hypothetic and Precambrian, and its most direct expression and outcome is his genus *Rustella* which, leaving no successors (in this table), stands out in independence as the fortified protegulum adult. Nearest to this in close collateral development stands *Paterina*, a durable genus reaching nearly through all Cambrian beds. From a distinct collateral descend the oboloids and in a near-by line, but distinct as far as it has been tracked, the linguloids. These three lines constitute the main stocks of the *Atremata*.

The *Neotremata* with definite cardinal surfaces (such genera as *Acrotreta, Acrothele, Trematobolus*) indicate no marked convergence toward the *Atremata*. Mr. Walcott unites them close to the Precambrian radicle. This also he does with the *Protremata* (*Billingsella, Syntrophia*, etc.). Indeed, one of the striking features of this table is its palpable absence of evidence of Cambrian convergence in the three great subclasses.

In 1892–94, when Hall and Clarke's "Introduction to the Study of the Genera of Paleozoic Brachiopoda" and "Introduction to the Study of the Brachiopoda" appeared, there were 28 recognized Cambrian genera. Dr. Walcott presents a total of 49 genera and subgenera of *Atremata* and *Neotremata* from the Cambrian. But it is to be noted that, notwithstanding its title, the work is not exclusively given over to the Cambrian faunas. The author has included a number of related genera and species, of all three subclasses, from the Ordovician, which help to make clearer the relations and range of these primitive expressions.

The scientific public knows that even with this vast contribution to our knowledge of the Cambrian fauna, Dr. Walcott's work is very far from complete. We have been let far enough into his accumulated Cambrian treasures to realize that his brachiopod book is but a foretaste, an intimation of the whole fauna under his eye. We can not restrain amazement at the tremendous expansion of ideas regarding the profusion and diversity of the Cambrian fauna which has followed the work of his hands. It is his own fault if we are led daily to expect the unexpected from this rich depository of life. In beauty and excellence of preservation the Cambrian beds of the Canadian Rockies, which he has especially upturned, surpass nearly all deposits of a later date, and with the light that they have cast upon familiar organisms long known to us from later beds, we have now to rehabilitate many familiar conceptions. In ultimate

significance the bearing of these investigations on the life conditions which preceded the Cambrian, is far-reaching, and must pave the way to a repair of our conceptions of it and gives us, too, a certain hope that unremitted diligence may bring to our distinguished protagonist of Precambrian life a sure and firm reward.

JOHN M. CLARKE

Nutritional Physiology. By PERCY G. STILES, Assistant Professor of Physiology in Simmons College; Instructor in Physiology and Personal Hygiene in the Massachusetts Institute of Technology, Boston. 12mo of 271 pages, illustrated. Philadelphia and London, W. B. Saunders Company. 1912. Cloth. $1.25 net.

This little volume is a most welcome addition to the literature of nutrition. It is seldom that as much information of a reliable and useful kind is condensed in a publication of this size. The author well states that "the making of the book has been a study in elimination." He also states that it is intended to be used with other books and suggests the desirability of supplementary reading upon general biology, human anatomy, food chemistry and dietetics. We are informed that the keyword of the discussion is energy. The author has given us a careful and discriminating study of the best existing scientific evidence related to the physiological phases of human nutrition and he has treated his subject in language that is notably clear. His discussion is well organized and he has exercised a reasonable caution in his affirmations. Chemical formulæ and minute details have been excluded from the text and "used but sparingly in the notes," for "a certain preliminary knowledge of elementary science is assumed." The volume deals with processes rather than with chemical or physiological details. For instance, in discussing the unlikeness of the individual proteins on the basis of the "building stones" into which they may be separated, no detailed list is given of the protein cleavage products, but at the same time the general bearing of the knowledge we now have in regard to protein cleavage and the nutritive relation of single food proteins upon the development of body proteins is clearly and fully presented. The origin of urea is discussed, but it is assumed that the student is familiar with the chemical reactions involved. In fact, we have presented to us the philosophy of nutrition minus minute chemical and physiological details. The evident intention is to give to the student a point of view and this purpose is accomplished with eminent success.

One of the characteristic features of this book is the type of illustrations used in order to make clear certain metabolic processes and nutritive relations. For instance, in dealing with the difference in the constructive value of the individual proteins, comparison is made to a house that is pulled down in order that another may be erected from its timbers. "If the second house is of an architecture entirely unlike that of the first, there will be many unavailable pieces to discard and the new building will be smaller than the old. It is not at all unlikely that the misfit fragments of building material will go into the cellar of the new house, later to be used as fuel. This is just what the body does." The structure of a molecule of food protein is also compared to type set up in a printed page. If this type is allowed to fall apart, it is a symbol of digestion and unless this is used to set up again exactly the same matter, there will be unused letters, just as in the human body protein building stones will be used for fuel purposes and not for construction unless the food proteins and the body proteins are alike in constitution. Familiar illustrations of this apt character are frequently used throughout the volume.

If any one portion of this volume is to be commended above another, it is the chapter upon the hygiene of nutrition. Though covering but twenty-three pages, this chapter has more value in its relation to practical dietetics than some whole volumes written by a less scholarly and discriminating author. In discussing nervous conditions as relating to digestion, some space is given to the treatment

of children as affecting the digestion of their food. It would be well if all parents could be made to heed the author's suggestions in regard to thoughtlessness in rebuking children at the table and the almost cruel practise of forcing them to eat what they dislike. The statements that "there is an element of hypocrisy in the attitude of parents who are selecting precisely what they please to eat while compelling little children to swallow food which repels" and "to oblige a child to finish a plateful of food against its inclination may be crass brutality" are forceful and should be heeded by those who have the care of the physical development of children.

The reader can but wish that the author had been more free in the use of cuts, for those which are given are very helpful.

W. H. JORDAN

NEW YORK AGRICULTURAL EXPERIMENT STATION

Studies in Radioactivity. By W. H. BRAGG, M.A., F.R.S. Macmillan. 1912. Pp. x + 196. $1.60.

Physics owes to Professor Bragg two of the most important of its recent advances. He first conceived and successfully carried out experiments on the "range" of corpuscular radiations and on the "stopping power" of different substances for these radiations. These experiments, with those on scattering, which inevitably followed, have been chiefly responsible for such additions as have recently been made to our knowledge of the internal structure of the atom. The first 10 chapters—104 pages—of the book in hand are taken up with a presentation in clear, nonmathematical language, of the present status of our knowledge of "range," "stopping power," "scattering" and "ionization" as these terms apply to the α and β particles. This material, culminating in C. T. R. Wilson's beautiful photographs of the tracks of α and β particles, probably marks the end of the conception of the positive charge of the atom as a uniform sphere of positive electrification. It seems to demand instead some sort of a Saturnian atom.

Bragg's second important contribution has consisted in the amassing of evidence for the inter-convertibility of β rays and X rays, or β rays and γ rays. This evidence is presented in the second half (pp. 104–196) of his book, which deals wholly with studies on the nature of X and γ rays. That this evidence is exceedingly convincing admits of no dispute, but that it can be successfully interpreted in terms of a neutral pair theory is more than doubtful. Indeed so rapid have been the strides made during the past year in establishing the essential identity of X rays and light that I fancy that Professor Bragg himself would today interpret all his results in terms of an ether pulse theory instead of a neutral doublet theory, but it would have to be an ether pulse theory of the J. J. Thomson sort, in which the energy remains localized in space instead of being distributed uniformly over the wave front. For a clear statement of the apparent necessity for some sort of a localization of radiant energy in the wave front the second half of Professor Bragg's book could scarcely be excelled. One might wish that the author had brought out more emphatically the parallelism between the behavior of X rays and ultraviolet light, for it is in this parallelism that the chief argument against the neutral doublet theory is found.

The book is invaluable to every student of the absorbing problem of the nature of radiant electromagnetic energy.

R. A. MILLIKAN

UNIVERSITY OF CHICAGO

BOTANICAL NOTES

POLYSTICTUS VERSICOLOR AS A FOOD PLANT

IN the course of some investigations made by Professor M. R. Gilmore in August, 1912, on the knowledge and use of the indigenous plants by the Dakota nation of Indians, the economic botany of the Dakotas, he learned of the use of *Polystictus versicolor* as a human food. The Dakota name is *Chaⁿ naⁿ pa,*[1]

[1] The raised n signifies a vanishing sound something like the French n.

which literally means "wood-ears" or "tree ears," the name, no doubt, being suggested by the shape of the fungus. It is used when young and tender and is prepared by boiling. Mr. Gilmore's informant was a man probably more than sixty years of age, speaking only the Dakota language, a man of more than average intelligence, a judge in the Indian court of the Wakpamni district of Pine Ridge Indian Reservation. He is of the Ogallala tribe of the Teton Dakotas.

AN EVERYDAY BOTANICAL MANUAL

THERE is evidently no good reason in these days for ignorance concerning the names and general classification of at least the higher plants, if we may judge from the attempts that are made by writers and publishers to supply popular manuals and handbooks. Some of those published in the past have not had much more to commend them than the wish on the part of the writer to help people who were more ignorant than he concerning the plants of some more or less vaguely defined area of North America. And yet the poorest of these had some value, and no doubt helped many people who could not have been induced to buy a better book. No doubt botanists have sometimes been unduly impatient with books of this description, while the non-botanical public has managed to get some of the information about plants which it craved, and which it could not find in the more accurate scientific publications.

But these merely tolerant words need not be used in regard to Dr. C. A. Darling's "Handbook of the Wild and Cultivated Flowering Plants," which made its appearance the latter part of 1912. The preface states that the object of the book is "to furnish a convenient and easy means of determining the wild and cultivated flowering plants found in the East." In carrying out this plan the author has used dichotomous keys of a kind so easily followed that with proper care one need not "run off the track" before finding the name of his plant, in its proper place in its family, order, subclass and class. A hint is given as to the proper pronunciation of the scientific name when found, and an English name is provided for every species. A good glossary and (single) index closes this handy little book of 264 small octavo pages.

If this little book can find its way into the hands of the persons for whom it has been prepared it will serve a most useful purpose, and this part of the public may well feel indebted to the author who in addition to his duties as an instructor in botany in Columbia University has taken upon himself the very considerable labor of writing and publishing this little book.

THE EVOLUTION OF PLANTS

ONE of the most helpful books for the beginner in philosophical science is Professor D. H. Campbell's "Plant Life and Evolution," in Holt's American Nature Series, which appeared some months ago. It will be remembered that a dozen or so years ago the same author brought out a book entitled "Lectures on the Evolution of Plants," in which he emphasized the structural side of his topic. The book now under consideration, while considerably less technical, is really a supplement to the earlier work. That book arranged plant structures in evolutionary sequence; this one accounts for the structures, and their changes by a discussion of the factors concerned. The earlier book was structural, this one is philosophical. The first one appealed primarily to the botanist, while this one will appeal to a much wider circle of readers, in proof of which we may cite some of the chapter headings: *e. g.*, factors in evolution; the origin of land plants; environment and adaptation; the problem of plant distribution; the human factor in plant evolution; the origin of species, etc.

CHARLES E. BESSEY

THE UNIVERSITY OF NEBRASKA

SPECIAL ARTICLES

SUPPLEMENTARY NOTE ON THE SIGNIFICANCE OF VARIETY TESTS

SINCE the appearance in SCIENCE[1] of a note "On the Significance of Variety Tests," Dur-

[1] N. S., 36: 318-320, 1912.

ham[2] has arranged the data of the trials of peas made at Wisley in 1911[3] in a convenient form for statistical analysis.

Comparison with the wheat data already discussed is interesting. In wheat, selection has been *primarily* in the same direction—largeness of yield in bushels per acre—for all varieties. In peas, it has been in diverse directions. For the character here dealt with—time required for development—the tendency has been, consciously or unconsciously, to differentiate widely the varieties. Hence in the pea data, it is idle to lump all the materials together, for any constant thus obtained would be largely spurious and insignificant.[4] In practical tests one must decide between a series of closely similar strains—not between those which are widely and obviously differentiated; hence, we split the material up into the four classes recognized by Durham, that is, into 81–90, 91–100, 101–110, 111–120 day peas and calculate the inter-period correlation[5] for each class separately for the only economically important character[6] for which data are available—total days required for the formation of usable pods. Hence, designating by the subscripts 1, 2, 3, the three successive cultures of 1909[7] we have the following relationships:

For 91–100 day peas, $n = 30$,

$r_{12} = .16 \pm .12$, $r_{13} = .19 \pm .12$, $r_{23} = .12 \pm .12$

For 101–110 day peas, $n = 40$,

$r_{12} = .43 \pm .09$, $r_{13} = .37 \pm .09$, $r_{23} = .78 \pm .04$

For 111–120 day peas, $n = 18$,

$r_{12} = .27 \pm .15$, $r_{13} = .50 \pm .12$, $r_{23} = .45 \pm .13$

All the values are positive. Their wide fluctuation and the magnitude of the probable errors is probably largely attributable to the necessary smallness of the number of varieties in each class.

It is clear that a single test when carried out in the manner of those of the Royal Horticultural Society has little decisive value concerning the merit of a variety. This is not intended as a criticism of these tests, for they are in comparison with many others apparently of a very high order of merit. But certainly they lend their emphasis to the point[8] made in the preceding paper.

Is it not time for a concerted and systematic effort on the part of those interested in agricultural science to put this important problem on a sound basis, biologically and statistically?

J. Arthur Harris

Cold Spring Harbor, N. Y.,
December 21, 1912

[2] Durham, F. R., "An Analysis of the Pea Trials at Wisley, 1911," *Journ. Roy. Hort. Soc.*, 38: 67–72, 1912.

[3] "Pea Trial at Wisley, 1911," *Journ. Roy. Hort. Soc.*, 37: 403–424, 1911. The two original papers must be consulted for the details that are here excluded for lack of space.

[4] As a matter of fact these constants have been calculated for another purpose, but they need not be published here.

[5] To be of value in determining the relative merit of varieties the performances of a given strain in a test should be a good basis for prediction as to the results of a subsequent experiment. To what extent this is true may be determined for any two or more series of trials of a number of varieties by determining the coefficient of correlation between their performances, correction being made when symmetrical tables are involved—*i. e.*, when any determination is used both as a first and as a second member of a pair—for environmental heterogeneity from experiment to experiment. This does not apply to the pea data.

[6] The data for the individual growth periods give, on the basis of the total data, such irregular correlations that it is not worth while to consider them for the subclasses.

[7] Had the cultures been made at the same season in three succeeding years, the test would have furnished data of more value to the practical grower. Data for such tests are, as far as I am aware, not available.

[8] This has already been emphasized on general grounds by various students of agronomy. See especially C. V. Piper and W. H. Stevenson, "Standardization of Field Experimental Methods in Agronomy," *Proc. Amer. Soc. Agron.*, 2: 70–76, 1910.

ON THE METAMORPHOSIS OF AN AMŒBA, VAHLKAMPFIA SP., INTO FLAGELLATES AND VICE VERSA[1]

An amœba of the limax group isolated, in 1909, from tap-water in Oakland, California,

[1] Presented to the Cincinnati Research Society, January 9, 1913.

was studied during the past year under varying conditions of environment. The culture contained the descendants of a single amœba grown in symbiosis with a single species of bacillus.

My work was started with the idea of investigating the physical and chemical conditions necessary for the growth of this particular amœba. When, in the course of the work, it was discovered that the trophozoits had the ability to turn, apparently at will, into actively motile flagellated forms, my efforts were directed mainly towards investigating, first, the effects of varying environment upon the morphology and development of the amœba and, second, the conditions which led to the production of flagellated forms.

The trophozoits usually possess a single nucleus with the large karyosome and thick nuclear membrane characteristic of members of the limax group.

The flagellated forms vary in shape, but are most often egg-shaped or pyriform, with the nucleus situated at the pole, from which two long, delicate flagella arise.

These flagellates disappear instantly if a thin cover-glass is placed on a preparation, but may be watched for varying lengths of time in a hanging drop. The metamorphosis of one may be described briefly as follows: For a while it maintained the elongated form; then became pyriform, and whirled round and round, and in a minute or so, during its gyrations, it projected numerous waves of blunt pseudopodia; shortly it became elongated again. It progressed in this form until twenty minutes after the observation commenced, when it suddenly became motionless and spherical. In a few moments it projected a clear blunt pseudopod into which the endoplasm flowed and then it wandered off as a typical trophozoit of the limax type.

Throughout a long series of cultural experiments it was found that this metamorphosis occurred very inconstantly. Traces of various monovalent and bivalent salts seemed to exert no beneficial effect. Daily observations on one subculture were made during more than two months without revealing any flagellated forms. However, it was finally discovered that if the trophozoits were first grown in hen's ovomucoid containing a trace of the egg yolk, the development of the flagellated forms was favored. Furthermore, that they could be constantly obtained if the cultivations were carried out in hanging drops placed in contact with an abundant supply of free oxygen.

The technique is as follows: a loopful from the surface of a yolk-ovomucoid culture containing the trophozoits is mixed with two or three loopfuls of distilled water on a cover-glass and placed on a Barber moist chamber at 22°–25° C. No flagellates may be seen in an hour or so, but hundreds may be seen after three or four hours.

Two "pure lines"—each originating from a single flagellate—were obtained for me by Dr. G. L. Kite, by means of the Barber isolation pipette. Both of these showed a much greater tendency to flagellate than the original stock.

Since the ability to turn over into a flagellated stage has been established as a generic character, a technique which will enable one to determine this power is evidently of importance.

In 1912 Chatton and Lalung-Bonnaire established the new genus *Vahlkampfia* (in honor of E. Vahlkampf, who was the first to make known the characteristic mitosis of these amœbæ) to include those members of the limax group which had the ability to flagellate. These amœbæ are said to be always uninucleated. Nuclear division is by promitosis. They multiply after nuclear division by simple fission. Their cysts are always uninucleate.

My findings show that these generic characters must be greatly extended. For example, under certain cultural conditions the trophozoits form endogenous buds; under other conditions, characterized by a reduced oxygen tension, the nucleus apparently divides repeatedly by amitosis, without division of

the cytoplasm, thus giving rise to large multinucleated forms containing as many as thirty or forty nuclei. When these multinucleated forms are placed in contact with an abundant supply of free oxygen the cytoplasm immediately begins to divide. Furthermore, the free oxygen supply starts off many of the multinucleated forms and their nuclei divide simultaneously.

These findings have raised the question, in my mind, as to the validity of the multinucleated genus *Pelomyxa* and the binucleated genus *Sappina*.

It may be of interest to describe here a reaction which I believe indicates the presence of peroxides in the living cell. When these amœbæ are grown in ovomucoid containing a trace of sodium carbonate and then mounted in an aqueous solution of Grübler's methyl green, the granules within their cytoplasm exhibit a purple color in a few minutes. The nucleus does not give this reaction. Now methyl green is split by peroxides into a purple compound and this reaction occurs in the test tube only, in my experience, in the presence of traces of sodium carbonate.

If this reaction really indicates the presence of peroxides, it shows that the so-called "nutritional granules," or "plastids" in reality perform an important part in the oxidations of the cell, and would seem to add significance to the observation of Kite and Chambers, who found that the nucleus of the spermatogonia of the squash bug was composed of powerful reducing substances.

The complete details of this work will be sent to the *Archives für Protistenkunde*.

Wm. B. Wherry

Cincinnati, Ohio

THE ILLINOIS STATE ACADEMY OF SCIENCE

The fifth annual meeting of the Illinois State Academy of Science was held at Bradley Polytechnic Institute, Peoria, Illinois, on February 21 and 22, 1913, under the presidency of Professor Henry Crew, of Northwestern University. After the opening business was transacted, the president's address was given by Professor Crew upon the title, "An Italian Academician." This address presented Galileo as an experimenter of the highest type—one who used the method of science in discovering some of the truths of nature at a time when the common practise was to deal with assertions about nature, or if the apparent facts of nature seemed to controvert assertions "to stare nature out of countenance." It is hoped that this excellent address will receive wide publication, for Professor Crew's special studies of the work of Galileo have resulted in the presentation of Galileo as a man of very much more far-reaching significance to modern science than most scientists have thought. Another special feature of the program was a symposium upon the "Science of Sanitation." The topics and speakers in this symposium were: "The Influence of Shallow Wells on Health," by Edward Bartow, director of the Illinois Water Survey, University of Illinois; "The Control of Stream Pollution," by Paul Hansen, Illinois Water Survey, University of Illinois; "Sanitary Aspect of Milk Supply," by P. G. Heinemann, department of bacteriology, University of Chicago; "Housing in Relation to Health," by Marion Talbot, department of household administration, University of Chicago; "Birth and Death Registration," by Frederick R. Green, American Medical Association, Chicago. This symposium proved unusually interesting to all the members who were present, and it is hoped by means of the annual volume of the academy's *Transactions* to give the symposium papers wide distribution throughout the state.

After an informal reception for members and friends of the academy, an excellent dinner was served by the department of domestic science of Bradley Polytechnic Institute; and in a period when efficiency in education is being demanded everywhere, it is a pleasure for the members of the academy to attest the efficiency of the service given by Bradley's domestic science department. The dinner and the service was entirely by students in the department, and no better dinner has been served to the academy. The after-dinner program consisted of a series of short addresses outlining the nature and significance of the past year's discoveries in each of several branches of science. This apparently impossible task was performed in such a way as to give the members a good perspective regarding the chief occurrences and the dominant points of view prevailing at present. The speakers were John M. Coulter, Henry B. Ward, Stephen A. Forbes, William S.

Bayley and E. W. Washburn. One of the purposes of the academy is to make science the property of the people, and no part of the program better met this purpose than these brief addresses which gave specialists in one science clear notions of the things being done in other sciences. The evening address was by Professor E. E. Barnard, Yerkes Observatory, University of Chicago, upon "Some Late Results in Astronomical Photography," and was illustrated with lantern slides made from the most recent and most valuable astronomical photographs. As the lecture ended doubtless a good many members felt as one said: "There is no mind-stretcher equal to astronomy."

The academy has had several committees at work during the past year, among which are the following: on conservation, on legislation, on calendar reform, on leaflets on high school science, on pure and applied science in high schools, on ecological survey. All of these committees are continued so that they may make further report next year, but the report of the ecological survey committee, S. A. Forbes, chairman, should be especially mentioned. The districts actively investigated and made the basis of special reports, printed or to be printed, are: the Chicago area; the Beach area of northeastern Illinois; the county of Jo Daviess in the northwestern part of the state and Fulton County in the central part of the state; the sand prairies of the state; the Charleston area with extensions over the eastern Illinois; and the Illinois River, with extensions to the Mississippi and the Ohio rivers. A statistical survey of the bird life of the entire state, made four years ago, showing numbers, distribution and ecological relations of the species is now being prepared for publication. The ecological relations of the crawfishes of Illinois are being investigated by a special student. The work upon the animal life of the Chicago area is soon to be published by the Geographic Society of Chicago. While this is not a part of the work of the academy, it has been done by one of its members, Dr. Shelford, and constitutes a part of the ecological work of the state. Dr. E. N. Transeau is publishing a report upon the algæ of eastern Illinois, a report which notes 245 species, 28 of which have not previously been collected in North America, almost all these new forms having been found in old prairie ponds. Mr. T. L. Hankinson reports a most interesting and careful study of the distribution of the fishes of Coles County, a county drained partly by the Wabash system and partly by the Kaskaskia system, thus offering peculiarly good opportunity for such a study.

The individual papers upon the program of the academy follow:

"A Celestial Sphere," an apparatus to be used in the study of descriptive astronomy, constructed and installed at the Chicago Academy of Science (illustrated), W. W. Atwood, Chicago Academy of Science.

"Chicago Academy of Science—An Educational Force in the Community" (illustrated), W. W. Atwood, Chicago Academy of Science.

"Annotated List of the Algæ of Eastern Illinois," presented in form of a summary, E. N. Transeau, Eastern State Normal School.

"The Sexton Creek Limestone in Illinois," T. E. Savage, University of Illinois.

"A Plea for the Organization of Local Natural History Societies," Ruth Marshall, Rockford College.

"A New Species of Marionina from Illinois," Frank Smith and Paul S. Welch, University of Illinois.

"A Black-crowned Night Heronry" (illustrated), Charles W. Finley, Western State Normal School.

"Reproduction by Layering in the Black Spruce," George D. Fuller, University of Chicago.

"Studies of Evaporation and Soil Moisture in the Prairie of Illinois," George D. Fuller and E. M. Harvey, University of Chicago.

"The Stratification of Humidity in the Forest," Wade McNutt, Highland Park High School, and J. R. Locke, Streator High School.

"The Distribution of the Fish in the Streams about Charleston, Illinois," T. L. Hankinson, Eastern State Normal School.

"The Disappearance of the Beaver," Elliot R. Downing, University of Chicago.

"The Stratigraphy of the Chester Group in Southern Illinois," Stuart Weller, University of Chicago.

"Cloud Studies" (illustrated), M. L. Fuller, United States Weather Bureau, Peoria.

The new officers for the following year are:

President—F. W. Dewolf, State Geological Survey, Urbana.

Vice-president—H. S. Pepoon, Lake View High School, Chicago.

Treasurer—J. C. Hessler, James Millikin University, Decatur.

Secretary—E. N. Transeau, State Normal School, Charleston.

The academy has a membership of over four hundred, forty-five new members having been elected at the recent meeting.

OTIS W. CALDWELL,
Secretary

SOCIETIES AND ACADEMIES

THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

The fourteenth regular meeting of the society was held at the residence of Dr. Stiles, February 6, 1913, Dr. Stiles acting as host and Dr. Cobb as chairman.

Dr. Stiles presented a note on "The Value of Protozoa in Determining Fecal Contamination of Foods." *Entameba coli, Lamblia duodenalis* and *Trichomonas intestinalis* are obligate intestinal parasites having an easily recognizable spore stage. Any given case of infection is *prima facie* evidence of fecal contamination of food, and of insanitary surroundings. The indicator value of these protozoa, a thing which has been overlooked heretofore, is greater than that of *Bacillus coli*. In some parts of the south, infection with these protozoa will range from 10 to 60 per cent. of the persons examined.

Dr. Stiles presented a note by Stiles and Boatwright on "Subjective Symptoms of Thymol." The paper notes the results of 464 administrations of thymol to 244 patients, each patient receiving 1 to 7 treatments. Of the 464 administrations, 55.8 per cent. had no untoward effect; 44.2 had effects of some sort; 14 per cent. had nausea due to thymol or to Epsom salts; 13 per cent. had weakness due to thymol, Epsom salts or the lack of breakfast; 9 per cent. had a burning sensation referred to "the stomach," due to thymol; 9 per cent. had dizziness; 3 per cent. had headache; 2.8 per cent. had attacks of vomiting; 1.7 per cent. had a burning sensation in the throat; 1 per cent. had pain in the stomach; 1 per cent. complained of sleepiness. There was one case of dyspnea due to idiosyncrasy to thymol, and one of fainting due to idiosyncrasy to Epsom salts.

Mr. Crawley presented the following note on "Initial Stages of *Sarcocystis* Infection."

According to Erdman, the spore of *Sarcocystis muris* germinates in the intestine of the host and liberates a toxin, sarcocystin, which causes the adjacent digestive epithelium to be thrown off. The spore sets free an amebula which penetrates the denuded area and attains the lymph spaces of the submucosa, where it establishes itself and remains for 28 to 30 days.

My own observations indicate that the above account is far from correct. Feeding experiments carried on during the past few years shew that the spore, under the form in which it occurs in the cysts, bores its way into the cylinder cells of the epithelium, occurring in some cells two or three hours after feeding, and there comes to rest. The spore changes in shape, becoming broadly elliptical or round, concomitant internal changes resulting in the production at the periphery of a row of masses of chromatin closely resembling stages in the schizogony of a coccidian. This point may be attained twelve hours after feeding. At the end of twenty-four hours the parasites appear to have abandoned the intestine.

According to my observations, the epithelial denudation mentioned by Erdman follows instead of preceding the invasion of the cells, a phenomenon well known as a sequel of heavy infections by other protozoan parasites.

Dr. Cobb presented some figures and specimens of free-living nematodes. Some marine forms have structures suggesting similar structures in insects and birds. One of them has a proboscis which might function in much the same way as analogous organs which in birds or insects are used for extracting food from flowers.

Dr. Cobb suggested that the clumsy term *lateral organ* be dropped as a descriptive term, since there are many other nematode organs which are also lateral. Since we do not know the true nature of this structure, he suggested the substitution of the new term *amphid*, which is compact, descriptive and yet non-committal as to function. For somewhat similar reasons he suggested that the *ventral gland* be called the *rennette*. Nematodes possess many other ventral glands. He has previously published a note on the urea content of this structure, thus justifying the functional implication carried by the diminutive rennette (*ren*, kidney).

The secretary presented a note by Dr. Albert Hassall, on "Nomenclatural Oddities." Certain rules of the code of zoological nomenclature are not observed by some writers, and some practises not contrary to the code are nevertheless undesirable from many standpoints. Disregard of the code and of good usage makes considerable trouble for the bibliographer, cataloguer and indexer. Common offences are: The casual introduction of unnecessary synonyms or the deliberate substitution of new names for old on grounds that never had recognition in the code; the proposal of new

names in footnotes, indices, figure labels or other out-of-the-way places; the habit of labeling a name *new species* in two or more publications; and the naming of new species by flocks of workers, so to speak, some specific names being *referable* to a chain of as many as five authors who have collaborated in the description.

By unanimous vote the society instructed the secretary to prepare a letter protesting against the proposed changes in the international code of zoological nomenclature which are being advocated by the German Zoological Society, and to submit the protest to the Ninth International Zoological Congress.

MAURICE C. HALL,
Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE 466th regular meeting of the Anthropological Society of Washington was held in room 43 of the new building of the National Museum at 4:30 P.M., February 18, 1913, the president, Mr. George R. Stetson, in the chair.

Professor W. H. Holmes read a paper on "Agricultural Implements of the Mound-builders," saying:

The rich alluvial and prairie country of the middle Mississippi Valley is especially adapted to the practise of primitive agriculture and here are found large numbers of skillfully made flint blades of large size suitable for hafting as hoes and showing unmistakable evidence of long usage in operations that gave the working end a high degree of polish. They are made of grayish flint or chert which occurs plentifully in the form of flattish nodules in southern Illinois. These nodules were readily shaped by fracture with stone hammers, and vast numbers were gotten out and worked up by the mound-building tribes. The processes of manufacture were demonstrated by the speaker and it was shown with what ease and rapidity the blades could be made.

It was also shown by examples obtained from the Missouri River tribes that hoes made of the scapulæ of the buffalo were in use in very recent times and that the hoes found in excavating ancient sites near Omaha correspond with these recent Indian forms in shape, manner of hafting and surface polish, and that both display, although in bone, precisely the same kind of polish and markings as do the similarly shaped hoes of flint. It was suggested that these flint hoes were modeled after scapular hoes, since these were in general use by the tribes and have doubtless been in use from very early times among all the tribes advanced to the sedentary agricultural status of culture.

Referring to questions of antiquity which have been raised recently in regard to the burials of the Omaha district, it was suggested that since the buffalo was a comparatively recent arrival in the Mississippi Valley, a culture in which the bones of buffalo are represented must be younger, not older, than that of the mound-builders, since no traces or pictorial representations of the buffalo are found within the older Indian mounds.

This paper was briefly discussed. Mr. Stetson read notes on certain implements lately found in Britain. Professor Holmes commented concisely thereon.

Professor Holmes then read a paper on "Scope and Relationships of History and Archeology."

The second paper embodied in outline a study of the nature and scope of archeology and of archeological research as related to the field of human history as a whole. The history of man, or anthropology, according to Powell's classification, may be considered under seven heads or departments, giving rise to as many branches of research, as follows: somatology, psychology, philology, sociology, sophiology, technology and esthetology. In working out its problems each of these seven branches employs every available agency of research within and without its particular field and makes use of every form of record in which the history of man is embodied.

The records or sources of information to be drawn upon in these researches are comprised under two principal heads: intentional or purposeful records, on the one hand, and non-intentional or fortuitous records, on the other.

The intentional records are of four forms, as follows: (1) pictorial or pictographic; (2) commemorative, taking the form of monuments; (3) mnemonic, in the form of tradition and lore, orally transmitted; (4) inscribed or written records. Fortuitous records take numerous forms: (1) the diversified material results of human activities in which the commemorative motive is absent, but which comprise the great body of the products of handicraft; (2) the immaterial results of human activity as embodied in language, beliefs, customs, music, philosophy, etc.; (3) the ever-existing unpremeditated body of memories which accrue to each generation and are in part transmitted adventitiously; (4) the record em-

bodied in the physical constitution of man which when properly read tells the story of his development from lower forms; (5) the record of intellectual growth and powers to be sought and studied in the constitution of the mind; (6) the environments which reveal the story of the nurture and building up of the race throughout the past.

It is from these diversified records of present and past times that the story of the seven grand divisions of the history of man must be drawn. Archeology stands quite apart from this classification of the science, traversing in its own way the entire field of research. It claims for its own more especially that which is old or ancient in this vast body of data. It is even called upon to pick up the lost strands of the earlier written records, as with the shadowy beginnings of glyphic and phonetic writing, and restore them to the historian. It must recover the secrets of the commemorative monuments, the tombs and temples intended to immortalize the now long-forgotten great. It must follow back the obscure trails of tradition and substantiate or discredit the lore of the fathers. It must interpret the pictorial records inscribed by the ancients on rock faces and cavern walls which men meant should last forever. All that archeology retrieves from this wide field is restored to human knowledge and added to the volume of written history.

The services of archeologic science are equally potent in the field of the fortuitous records of humanity, for it reads that which was never intended to be read. The products of human handicraft, present and past, which have recorded automatically the doings of the ages are made to tell the story of the struggles, the triumphs and the defeats of humanity. The fortuitous records embodied in the non-material products of man's activities of to-day, although in themselves not antiquities, are made to cast a strong light on the history and significance of the material things of the past. Even the body of knowledge gathered from many sources and stored in the memory of the living, though unreliable and transient as a record, may be made to illumine the past; and the physical and psychical characters of man are in themselves records and may be made to tell the story of their own becoming and to explain the activities and the products of activity throughout the ages. All that archeology gathers from this wide field of research is added to the volume of written history.

In the great work of assembling the lost pages and completing the volume of the history of man, archeology may well claim first place among the contributing sciences.

This paper was discussed by Messrs. Casanowicz, Carroll, Stetson, Babcock, Hewitt, Swanton and Neumann.

A SPECIAL meeting of the Anthropological Society of Washington was held March 6, 1913, at 4:30 P.M., in the auditorium of the new building of the National Museum, the president, Mr. George R. Stetson, in the chair.

Dr. Walter Hough read a paper on "Savage Mutilations for Decoration."

The paper was a short excursion into the enormous field of custom with regard to ethnic mutilations, and sufficient examples were given to lay the subject rather completely before the society. In it were described the most striking forms of head shaping by pressure in infancy; the various forms of teeth mutilations; ear, nose, cheek and lip modifications and ornaments; pressure and mutilations in the arms, waist and limbs, and modifications of the bones of the feet. With mutilations also should be considered, perhaps, extraordinary hair dressing and treatment of the finger nails.

Many slides were shown of tattooing, scarification and decoration of the skin by means of dyes and pigments, and some of their multifarious meanings given. On the whole, it was concluded that ethnic mutilations originated from many concepts, the more important being a desire for identification, in some cases individual, but in most cases tribal; a desire for ornamentation, mainly individual in its treatment, but following environmental and tribal fashions; and also very important mutilations growing out of superstitious and religious ideas.

Many ethnic mutilations also relate to sex, puberty, social rank, honor for warlike feats and the like. All these ideas, which at times have been advanced as the explanation of the causes, show that the matter is extremely complex. The bearing of ethnic mutilations on primitive surgery was also hinted at, as well as its effects on the development of costume.

Dr. Williams and Dr. Swanton made certain inquiries and brief appurtenant remarks, which Dr. Hough answered.

WM. H. BABCOCK,
Secretary

SCIENCE

FRIDAY, APRIL 4, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE SIGNIFICANCE OF PLEISTOCENE MOLLUSKS[1]

IN the investigation of natural problems the most conspicuous or bulkiest character does not always furnish the most convincing evidence. We readily see the mass of diatomaceous earth, but we do not understand its gritty quality, nor can we appreciate its origin until we have studied the minute, individually almost negligible frustules which make it up; sandstones or limestones may form great cliffs, but it requires the comparatively insignificant fossil to finally reveal the origin and the place of the rock. Similarly, in the study of the Pleistocene we encounter gross features which have their value—we find variously comminuted and diversely arranged materials in great bulk; we find topographic and physiographic characters on a large scale; yet the best evidence which we have concerning the conditions under which certain parts of the Pleistocene formations were deposited is furnished by the fossils which usually form a small and not always conspicuous part of the deposits.

Both plant and animal fossils have been found in the various subdivisions of the Pleistocene. The former consist chiefly of the leaves and wood of gymnospermous and angiospermous trees and shrubs, mosses and diatoms; the latter of some insects, a conspicuous, though limited, mammalian fauna, and the mollusks which form the most widely distributed and most universally present group of all.

[1] Address of the vice-president and chairman of Section E—Geology and Geography—American Association for the Advancement of Science, Cleveland, 1912.

The plant remains and insects are too few and too widely scattered to form a satisfactory measure of conditions; the mammalian fauna is but little better in this respect and, moreover, consists of species which are for the most part extinct, and whose exact habits are not known; but the mollusks are not only most widely distributed in the Pleistocene deposits, but belong practically without exception to species now living whose habits may be very accurately determined. For these reasons the mollusks form the most important and most significant group of Pleistocene fossils.

Aside from the marine species of the coastal formations, which will not be here considered, the Pleistocene and modern species of mollusks naturally group into three rather well-defined divisions according to habits:

1. *Fluviatile species*, inhabiting perennial streams and lakes. These are chiefly bivalves, especially larger *Unionidæ*, and operculate gill-bearing gasteropods. A few aquatic pulmonates, like *Lymnæa emarginata* and *Planorbis truncatus*, also prefer larger bodies of water.

2. *Pond species*, inhabiting ponds, bogs and borders of smaller streams, which are likely to become dry during a part of the summer, and also the shallow swampy borders of larger bodies of water. These species are chiefly aquatic pulmonates, with a few smaller bivalves, especially of the genus *Pisidium*.

3. *Terrestrial species*, living among plants, sometimes on the bark of trees, often under leaves, sticks and stones. Among them are two operculate prosobranchs, closely related to aquatic species of the first group, but the great majority are terrestrial pulmonates. A few species, such as *Succinea retusa, Zonitoides nitidus, Vertigo ovata* and *Carychium exiguum*, naturally group with the terrestrial pulmonates, but they are commonly found in wet places, and sometimes live in the water for a time, behaving then like the aquatic pulmonates of the pond group.

The members of the pond and terrestrial groups are closely associated with plants which they require for shelter and in most cases for food. The terrestrial forms are most abundant on forested areas, but certain species, such as *Succinea grosvenorii, Cochlicopa lubrica, Vallonia gracilicosta*, etc., also extend into more open territory.

While all the terrestrial species require some moisture for activity, the amount which may be found at times under a leaf or stick, or among plants on a dewy morning, or after a rain, is entirely sufficient for the purpose. This supply of moisture is irregularly intermittent, and the mollusks remain inactive while waiting for a return of favorable conditions. Sometimes they protect themselves by a mucous epiphragm, or they creep under leaves or sticks, or burrow into the soil. Long-protracted dry seasons are fatal to many of them.

The fossil mollusks are distributed through a variety of formations. Those of the Aftonian, the Don beds, the Florencia formation and similar older Pleistocene deposits, like those of the more modern alluvial beds, present the fluviatile and pond facies in the main, though there is often a strong admixture of terrestrial forms. Those of the loesses are terrestrial in the main, with comparatively rare additions of pond types and a total absence of fluviatile forms.

Practically all of the species found in the various Pleistocene formations are living upon the continent to-day. Such exceptions as *Oreohelix iowensis* from the loess and species of *Pisidium* and *Lymnæa* recently described from indefinite alluvium,

do not materially affect the truth of this statement, for these may be mere races, or a more critical study of these difficult genera may show that the apparently extinct forms are living to-day. They are certainly very closely related to existing forms, and suggest no peculiar set of conditions.

Because of the practical identity of the fossil and certain modern molluscan faunas important conclusions may be drawn concerning the conditions which existed at the time of the deposition of the fossiliferous deposits.

The first question which naturally comes to the mind of the student of Pleistocene geology in this connection is this: Could these mollusks have lived under glacial or near-glacial conditions? As in so many other cases, the measure of the past must here be sought in the present. Unfortunately, we do not anywhere have conditions which exactly parallel those which existed in the interior of our continent during the several advances of the ice-sheets. The climate of Alaska is so materially affected by warm ocean currents that no fair basis for comparison can here be established. The Antarctic region presents no partly glaciated continents, and comparisons are here impossible. Perhaps Greenland offers the nearest parallel, but even here in the study of plant and animal life we have to deal with a narrow coastal strip the climate of which is manifestly affected by the proximity of the sea.

From this narrow strip Möller reported, in 1842, four species of terrestrial mollusks (a *Vitrea*, a *Pupa*, a *Vitrina* and a *Succinea*) and three species of pond snails, two of the genus *Lymnæa* and one of *Planorbis*. These species were all represented by few widely scattered individuals, and constitute a very scant fauna. Nowhere in all the barren ground belt bordering the Arctic ice have such combinations of species been observed as we find in the various Pleistocene deposits of our country. The latter suggest rather a region very similar to the present northern part of our country, in the main, with relationship in some of the deposits with the fauna of the southern states, and in others some affinity with that of the coniferous belt to the north.

Our present knowledge of the habits and distribution of the fossil and modern mollusks forces the conclusion that the deposits containing these species are interglacial or post-glacial, and that they were formed during a period of mild climate.

The second important question concerns the immediate conditions under which the various deposits were formed. To answer this question intelligently on the basis of the molluscan fauna we must understand the habits of the mollusks as well as the conditions under which the land and fresh-water forms may mingle.

For purposes of comparison your essayist has made extensive studies of the habits of the modern molluscan fauna of the Mississippi Valley, and has compared large series of shells thrown up along the shores of larger streams and their smaller tributaries, as well as ponds and lakes, with the shells obtained from various Pleistocene deposits and from more modern alluvium, and nowhere has he found any evidence that the conditions under which the Pleistocene deposits were formed were materially different from those which are in operation in the same region to-day.

All of the Pleistocene deposits, with the exception of the loesses and certain buried sand dunes, are aquatic, and a comparison of their molluscan contents shows the same peculiarities and the same variations as are presented by the modern alluvial and water-drifted fauna.

Some of these points of similarity are brought out by a comparison of the mollusks from various deposits. Thus the Aftonian beds of Harrison and Monona counties, Iowa, have yielded 28 aquatic species and 9 terrestrial species;[2] the Don beds, 42 species, of which all but two are aquatic;[3] the Florencia formation, 30 aquatic and swamp species and 19 terrestrial species;[4] the buried silt in the Illinois Central cut in Sioux Falls, 14 aquatic and 2 terrestrial species, one of the latter doubtfully belonging to the deposit;[5] the more modern river alluvium of Harrison County yielded 18 aquatic and swamp species and 19 terrestrial species;[6] the lacustrine alluvium of West Lake Okoboji exposed by recent canal excavations, yielded 27 aquatic and swamp species, and 1 terrestrial species; modern drift along the Big Sioux River opposite Canton, South Dakota, contained 18 aquatic and 5 terrestrial species; similar drifted material along the Missouri River at Rulo, Nebraska, showed 12 pond and swamp species, and 15 terrestrial species; and drifted material on the north shore of Miller's Bay, West Lake Okoboji, Iowa, contained 14 aquatic and marsh species and 14 terrestrial species.

These lists indicate that terrestrial mollusks are not uncommon in the various alluvial deposits. It should be remembered, however, that as a rule the terrestrial species are represented by very few individuals which accidentally drifted in from adjacent land surfaces, while the aquatic species belonging to the genera *Sphærium, Pisidium, Campeloma, Valvata, Amnicola,* the larger species of *Lymnæa, Physa, Planorbis, Segmentina* and *Ancylus* occur in larger numbers.

In those case in which larger numbers of terrestrial forms occur, as in the Miller's Bay and Rulo lists, they may be traced to nearby wooded bluffs, and it is evident that the relatively large number of terrestrial forms in the Harrison County alluvium and the Florencia formation may be traced to the same source.

It is evident that the shells do not drift far in any case. The Missouri River contains few aquatic mollusks, but its smaller tributaries usually show an abundance of them. Yet rarely are fluviatile shells found in modern river drift along the Missouri, and the aquatic species are of the pond type prevailing in small ponds along the main river, as is shown in the Rulo list. Shells of terrestrial species which are limited in their distribution are also seldom found at any distance from their habitat. This is strikingly illustrated by *Helicina occulta,* which is now restricted to limited and widely separated areas. Thus at Iowa City a colony inhabits a half-acre of wooded bluff, and in thirty years your essayist has found but one fresh shell along the creek at the foot of the slope, and none along the nearby river to which the creek is tributary.

A recently discovered colony of this species in a similar situation along the Cedar River above Cedar Rapids, Iowa,[7] gives like results. Various students of mollusks have collected in this region, yet no fresh shells of this species were ever observed in the drifted material along the Cedar River. The Miller's Bay list shows that 14 species of terrestrial shells were carried across the bay from the wooded southern shore, yet repeated dredging in the bay has brought

[2] See Iowa Geol. Survey, Vol. XX., 1910, pp. 395–6.

[3] *Journal of Geology,* Vol. IX., 1901, pp. 291–2.

[4] *Am. Jour. of Science,* 4th series, Vol. IV., 1897, p. 96.

[5] For description of this cut see *Bull. of the Geol. Soc. of Am.,* Vol. 23, 1912, pp. 141–3.

[6] Iowa Geol. Survey, *ibid.*

[7] By Mr. E. G. Grissel, of Cedar Rapids, Iowa.

to light only four of these species, represented by very few individuals, which had dropped to the bottom of the bay. Terrestrial shells which drift into water are soon cast ashore.

Nearby wooded slopes frequently contribute terrestrial shells to ponds and streams, but the latter invariably supply a relatively large number of shells of aquatic species.

It is also noticeable that such species as *Zonitoides nitidus* and *Succinea retusa*, of low grounds, and *Helicodiscus parallelus*, *Vitrea hammonis*, *Bifidaria armifera*, *B. contracta*, *B. pentodon*, *Zonitoides arboreus* and *Z. minusculus*, which are common on timbered alluvial flats and which occur so frequently in alluvium and modern river drift, are relatively very rare in terrestrial deposits like the loesses.

Another method by which terrestrial shells sometimes find their way into alluvial deposits has been observed where shallow ponds become dry during the summer. These ponds usually contain aquatic pulmonates, and their shells remain in the alluvium of the pond. Terrestrial species then creep out over the exposed surfaces, not infrequently leaving their shells to mingle with those of the pond species. The subsequent flooding of the pond results in the inclusion of both types in the alluvium of the pond. In the alluvium of one pond of this type between the Lakes Okoboji, Iowa, 12 aquatic and 5 terrestrial species were found, the latter being represented by few individuals.

Still another method by which aquatic species may be buried at altitudes higher than the level of the free water surface may be observed in seepy places fed by permanent springs. Such spots are not uncommon even on higher slopes and they frequently contain aquatic species belonging to the genera *Pisidium*, *Lymnæa* and *Physa*, probably introduced by small wading birds. Terrestrial species from nearby surfaces may creep out or be carried into the bog and the shells of both will then be mingled in the deposit of the bog. In one of these small bogs near Council Bluffs, Iowa, located at an altitude fully twenty feet above the high-water level of the Missouri River and closely surrounded by a forest, 5 terrestrial and 1 aquatic (*Pisidium*) species were collected, while in another on a prairie slope near West Lake Okoboji 3 aquatic species belonging to the genera *Pisidium*, *Lymnæa* and *Physa* were collected at an altitude of more than forty feet above the lake. In the latter case the surrounding prairie surfaces contributed no terrestrial species.

And finally individual specimens of aquatic species of mollusks may be carried to uplands by aquatic birds and insects, where their shells may ultimately be included in terrestrial deposits.

In order that the value of these molluscan faunas may be properly measured it is necessary that they be taken collectively. A single terrestrial shell does not make a land deposit, neither does a single aquatic shell make a water deposit. In water deposits aquatic shells always form a conspicuous part of the fauna, even though locally they may not predominate. In subaerial deposits aquatic shells may occur, but they are rare and local, and the dominant types are terrestrial. Strictly terrestrial Pleistocene deposits are of two types: buried sand dunes and the loesses. Buried sand dunes are not uncommon in the upper Mississippi Valley, excellent illustrations being found near Gladstone, Illinois; north of Iowa City, Iowa; at Hooper and West Point, Nebraska, and at other points. Neither buried nor surface dunes contain shells so far as observed.

The loesses are much more satisfactory

for our purposes, because they frequently contain fossils and offer by far the best opportunity for the study of Pleistocene terrestrial mollusks. In these deposits terrestrial forms vastly predominate, and fluviatile forms are wholly wanting. So much has been written on this feature of the subject that only reiteration is here possible.

Fresh-water shells in the loess are very few. They belong to species which inhabit small ponds and boggy places. They are not of the types found in streams and lakes. They are local in distribution, and in a number of cases clearly associated with buried ponds. Ponds are not rare in high places in loess regions. They frequently contain the smaller *Lymnæa*, etc., which are sometimes found in the loess, aquatic birds and insects probably being responsible for their introduction. Such ponds, if buried by subsequent depositions of loess, would present exactly the conditions under which aquatic shells are usually found in the loess. The vastly predominating forms are terrestrial—*upland terrestrial at that*. Some have become extinct in the loess region, but occur westward and southwestward in the drier part of the continent. Such are *Pupa muscorum, P. blandi, Sphyradium edentulum* var. *alticola, Pyramidula shimekii* and *Oreohelix iowensis*. Others like *Succinea grosvenorii* and *Vallonia gracillicorta* are still found in the loess region, but they prefer dry, often open grounds. The land species which prefer wet grounds are conspicuously absent from the loess.

The usual type of the fauna of the northerly loess is well illustrated by the fossil and modern fauna of King Hill, South St. Joseph, Missouri. This elevation rises 225 feet above the Missouri River bottoms and is capped by a thick bed of yellow loess which is quite fossiliferous to the very summit. The northeastern slope is covered more or less with low shrubs and stunted trees from twenty to eighty feet below the summit, merging below into a native grove. The loess at the summit yielded nineteen terrestrial species. Of these seven were also found living on the shrub-covered northeast surface in a relatively very dry habitat. With the latter were associated six additional terrestrial species which were not found in the summit loess, but all of which are known from the loess of the Missouri Valley. The nineteen fossil and thirteen modern species are all strictly terrestrial and the six species which are common to both well characterize the habitat of the entire fauna. A more careful examination of both the loess and modern surface faunas near the summit of King Hill would no doubt reveal a larger number of species common to both.

The fossil mollusks do not enable us to determine the age of any of the Pleistocene formations. The fossils of the Aftonian are not sufficiently distinct from those of modern alluvium to permit the drawing any conclusion other than that the conditions of deposition were much the same. They do not enable us to distinguish between the loesses, for the fossils of the gray and the yellow loesses are, in larger series, essentially the same. But they give us an excellent measure of the conditions which prevailed at the time of the deposition of the various fossil-bearing Pleistocene strata.

The fact that several ice sheets advanced into the upper Mississippi Valley has been well established. The advance and retreat of these several ice sheets were in all probability very slow, resulting in a gradual transition to and from a glacial climate. This suggested the desirability of search for evidence of such gradual transition among the mollusks of the several interglacial periods. But no such evidence has

as yet been found, and it is evident that the fossiliferous Pleistocene deposits were formed after the interglacial and postglacial conditions had been fully established.

In no known Pleistocene deposit is there a vertical gradation of species which can be accounted for on climatic grounds.

The variation in horizontal distribution does not in any case indicate a climate of greater severity than that which exists in the same region to-day. The determinable deposits containing fluviatile and other aquatic shells are of such limited extent north and south, and, moreover, the species which they contain are now so widely distributed that they present no evidence of climatic variation.

The terrestrial mollusks which are found in the Pleistocene deposits are also now of very wide distribution and the variation which they exhibit in species, form and size is not at all determined by latitude, but rather by the edaphic conditions under which the forms existed. In both cases the species are those of modern faunas whose habits are well known.

Variations in the Pleistocene fauna are nowhere better illustrated than in the loess, which has a wide distribution both north and south, and east and west, in the Mississippi Valley. If we begin in the northwestern part of the loess area in Nebraska and western Iowa, we find that the dominant species in the loess are *Pupa muscorum, P. blandi, Pyramidula shimeki, Succinea grosvenorii, Oreohelix ioensis, Vallonia gracilicosta, Bifidaria procera, Sphyradium edentulum alticola.* These species all belong to a fauna characteristic of the dry western regions, *Pupa muscorum* alone passing by a wide detour northward to the northeastern part of the country. Other species belonging to more easterly faunas appear, as a rule, in smaller numbers. Southward along the Missouri River, as in northwestern Missouri, larger forms, such as *Circinaria concava, Pyramidula alternata* and *Polygyra multilineata,* more characteristic of eastern and southeastern faunas, begin to appear in larger numbers. The change southward along the Mississippi is even more striking. In the northerly deposits along the Mississippi *Helicina occulta, Pyramidula striatella, Succinia ovalis* and *S. avara* are among the most common species. *Pupa decora* is also abundant in both northern and northwestern loess, and while it is largely a boreal species, like *Pupa muscorum,* it extends along the western mountains well into our dry western region.

Southward along the Mississippi the loess molluscan fauna changes in essentially the same manner as the modern fauna of the surface. At Hickman, Kentucky, the larger helices (so prominent in the southeastern modern fauna) already appear in large numbers and *Pyramidula solitaria,* carinate *Pyramidula alternata, Polygyra tridentata,* very large *P. albolabris,* large *P. profunda,* a few *P. elevata, P. fraterna, P. fraudulenta, P. appressa, Omphalina fuliginosa,* large *Circinaria concava,* more abundant *Pyramidula perspectiva* and *Gastrodonta ligera.* These species already form the most conspicuous feature of the loess fauna. *Helicina occulta* still appears, though here approaching its southern limit. Still farther south at Dyersburg, Tennessee, a similar fauna appears in the loess, but *Helicina occulta* is not common, reaching here its southern limit and *Pyramidula striatella,* so common in the north, also becomes rare. Still farther south on the west side of the Mississippi River at Helena, Arkansas, the loess fauna becomes still more characteristically southern, and in addition to the larger helices already mentioned the large

form of *Succinia ovalis, Omphalina kopnodes, Vitrea placentula* and *Helicina orbiculata* appear in conspicuous numbers. The last three species are distinctively southern. *Helicina occulta* has wholly disappeared and its place has been taken by *Helicina orbiculata.* The richly fossiliferous loess of Natchez and Vicksburg, Mississippi, also contains the forms common at Hickman and Helena, and the presence of *Polygyra obstricta, P. inflecta* and *P. stenotrema* still further stamps the fauna as distinctively southern.

But in this variation in the wide loess region there is nothing which suggests a transition or change from cold climate to warm climate faunas or *vice versa.* The variation, as we find it in the loess is practically exactly duplicated in the modern fauna of the surface. The only conclusion, then, which can be drawn from the fossils of the loess is, that during the deposition of the several loesses climatic conditions were not materially different from those which exist in the various parts of the same general region to-day. Such differences as do exist point rather to a drier climate in the northern part of the loess-covered area than that of to-day.

Emphasis has sometimes been placed upon the depauperation in size of certain loess shells, as evidence that the climate in which they existed was colder than that of to-day. These depauperate shells are found only in the northern part of the loess area, in Iowa, Nebraska, etc. Their exact counterparts are found living to-day in the drier portions of the same region. And corresponding differences do not occur in more easterly series which represent differences in latitude. It is evident that the depauperation is due to drouth and not to a low temperature, and the abundance of these depauperate shells in the northern loess reinforces the evidence already noted that the climate of this region was then somewhat drier than at present.

The earlier hasty conclusion in this case illustrates only one of the difficulties which the student of geology who has not given special attention to the mollusks encounters in his efforts to determine the conditions under which various Pleistocene deposits were formed.

Another results from erroneous identifications of deposits. An illustration of this is furnished by the Otis Mill section in South Dakota opposite Chatsworth, Iowa, which has been referred to the loess. The section, in fact, consists of Aftonian silt and sand, Kansan drift and true loess. The fossils, to which reference is usually made in connection with this section are of the usual alluvial type and belong to the Aftonian part of the section only, none being found in the capping loess. Still other errors result from erroneous identifications of species. Thus *Carychium exile,* the species usually found on high ground, has been identified as *C. exiguum,* a species which is frequently amphibious. Other errors arise from the assumption that species of the same genus have the same habitats, and that their presence in various deposits indicates like conditions. This is often far from true, thus, *Zonitoides arboreus* and *Z. nitidus* are similar in appearance, and closely related, yet the former is an upland species, while the latter is found in low grounds and is sometimes amphibious. Similarly, *Succinia avara* is upland, while *S. retusa* is amphibious; *Pomatiopsis lapidaria* is terrestrial, while *P. cincinnatiensis* is found only in somewhat deeper water in large ponds and lakes; *Planorbis trivolvis* lives in shallow waters in ponds and swampy borders, while the similar *P. truncatus* is found only in the larger lakes in deeper waters. *Lymnæa palustris* and *L. emarginata* show a similar difference in

habit, the latter being a deep water form; *Physa gyrina* is a species common in small ponds, while *P. integra* prefers river borders and *P. sayi* inhabits larger ponds and lakes; and similar variations in habit may be found in the species of various genera such as *Bifidaria* and *Vertigo* among terrestrial genera, and *Amnicola* and *Pisidium* among aquatic genera.

It is, therefore, not safe to jump at conclusions on the basis of mere relationship. A student of geology who would correctly measure the conditions which prevailed during the time of deposition of the various fossiliferous Pleistocene formations must not only accurately identify the fossil species, but he must learn to know the habits of the modern representatives of the same species.[8]

BOHUMIL SHIMEK
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RAMSAY HEATLEY TRAQUAIR

ICHTHYOLOGISTS all over the world have read with profound regret of the death of Dr. Ramsay Heatley Traquair, the eminent authority on fossil fishes. Dr. Traquair had long been regarded as the dean of paleichthyology, and had been revered by those in his field, both for his personality and his scientific achievements, as few men ever were. It was a shock to them to realize that he was no more among them. His work in ichthyology was of a fundamental kind, like that of Huxley or of Johannes Müller in zoology, and much of it has long since become incorporated among the established principles of the science. Indeed, Dr. Traquair may be regarded as the founder of modern paleichthyology, and his name, we believe, will stand next to that of Louis Agassiz, as the most illustrious in the history of this science.

[8] A supplementary table of mollusks, containing twelve lists of fossils and six lists of shells obtained from modern drift along streams and lakes, has been published by the author, and will be sent on application to members who are specially interested.

Ramsay Heatley Traquair was born at Rhynd, Perthshire, July 30, 1840. He was the youngest son of a Scottish minister. As a boy, he was sent to a preparatory school in Edinburgh, where his quiet bearing and studiousness attracted the attention of his teachers. Almost from childhood he manifested a deep love of nature, and as a boy he frequented a small natural-history shop kept by an old woman in Edinburgh, where were displayed minerals, fossils and shellfish: these no doubt stimulated his imagination and helped to nurture a growing love of natural history. As he grew older, he would go on excursions into the hills around Edinburgh in quest of paleichthyological specimens. On one of these trips, the story runs, he found a nodule with a portion of a palæoniscid fish, and was greatly surprised to learn that no book then available gave an adequate account of it. It was his ardent love of natural history that led to his choice of medicine as a profession, for this was the only science, at that time, that afforded both a foundation for natural history studies and the means of a livelihood. He entered the University of Edinburgh as a student of medicine in his seventeenth year, and he seems to have been a good student. His holidays were spent in collecting and studying fossils. As the end of his studies approached, it became more and more plain to him that he ought not to practise his profession but seek an opening in science. He took his degree in 1862, receiving a gold medal for his thesis on the asymmetry of flatfishes. In this year, too, he published his first paper, "On the Occurrence of Trilobites in the Carboniferous Limestone of Fifeshire."

For several years after graduation he held minor posts in the school of medicine, first as prosector and later as demonstrator of anatomy. This period afforded him an opportunity of acquiring skill in making anatomical preparations, besides allowing him to be near his favorite fossil hunting grounds. During 1866–67, he held the professorship of natural history in the Agricultural College at Cirencester, where he taught botany and devoted his spare time to the study of local geology

and fossil fishes. His well-known memoir on *Pygopterus* belongs to this period, having been published in 1867.

During the next six years he held the chair of zoology in the newly established College of Science in Dublin. This post was more congenial than his previous ones, but it is plain, from the few papers published during these years, that he lacked materials for carrying on his studies in paleichthyology. His opportunity, however, came in full measure in 1873, when he was appointed keeper of natural history in the Museum of Science and Art (now the Royal Scottish Museum), at Edinburgh. Shortly before leaving Dublin he married Miss Phoebe Anna Moss, whose work as a painter was just beginning to attract attention;[1] she is the daughter of the late Dr. William Moss, of Dublin.

Dr. Traquair held the post of keeper for thirty-three years, retiring in 1906 at the age of sixty-six. His most brilliant and most lasting work was done during this time. He had at his disposal a magnificent collection of paleozoic fishes, including the materials brought together by Hugh Miller and used by him in his preparation of "Old Red Sandstone" and other works. Moreover, within easy reach of Edinburgh were a number of localities where fossil fishes could be easily procured. But it should not be thought that Dr. Traquair devoted all his time, during these years, to his studies: he gave much attention to building up the zoological collections at the museum. The synoptic exhibit in this subject, which is displayed in a large square gallery, is one of the completest, and perhaps the best of its kind, in the world. It is the admiration of all zoologists who visit the museum.

[1] Mrs. Traquair is widely known for her mural decorations. Her principal work is the series of mural paintings in the Catholic Apostolic Church in Edinburgh, which took four years to complete and is mentioned as one of the sights of Edinburgh. She has also done exquisite work in book illumination, decorative bookbinding and in enameling. For an appreciation of Mrs. Traquair's work, see A. F. Morris, "A Versatile Art Worker," *The International Studio*, XXV., 1905, pp. 339–343.

A few years after Dr. Traquair's retirement his health began to fail and during the past year or two it was felt by his friends that the end could not be far off. He died in his seventy-third year, on November 22, 1912, in his beautiful home, at the foot of the Pentland hills, at Colinton, near Edinburgh.

Many honors came to Dr. Traquair in his lifetime. He was an honorary or corresponding member of many learned societies throughout the world, including the New York Academy of Sciences, to which he was elected in 1899. He became a member of the Royal Society of London in 1881; in 1893 his alma mater conferred on him an honorary LL.D. He received a number of medals in recognition of his services to science—the Neill medal of the Royal Society of Edinburgh in 1878, and the Makdougall-Brisbane in 1901; the Lyell medal of the Geological Society of London (1902), and a Royal medal of the Royal Society in 1907.

Dr. Traquair's studies were embodied in about 130 memoirs.[2] He was not a voluminous writer, as natural history writers go these days, but whatever came from his pen was so carefully, so conscientiously elaborated, that even his smaller papers were highly valued by those in his field. Fossil fishes are often very imperfectly preserved, and authors are occasionally carried away into seeing anatomical details where none really exist. But Dr. Traquair never let his imagination have sway where his specimens were imperfect. His accuracy was almost proverbial. Considering the vast amount of detail contained in his papers, it is remarkable how little of it has ever been debated. Indeed, Dr. Traquair has been considered by some even over careful, so that his results were sometimes held back for a long time before publication. Thus, Dr. A. S. Woodward has lately pointed out that Dr.

[2] A bibliography of Dr. Traquair's scientific writings appeared in the *Geol. Mag.*, dec. v, Vol. VI., 1909, pp. 245–250. His last publication was the memoir, "Les Poissons Wealdiens de Bernissart," published in 1911 (*Mém. Musée Roy. d'Hist. Nat. de Belgique*, VI., pp. iv + 65, 12 pls.).

Traquair had a specimen of *Palæospondylus* for years in his possession before publishing it to the world: he had apparently waited in the hope of being able to throw additional light on this elusive fossil.

The work of Dr. Traquair may be described as that of a morphologist working out anatomical structures as a key to relationships, rather than that of a systematist. Still he described, as one should, such new species as came his way—perhaps a hundred in all. His greatest service was in establishing clearly the limits and the relationships of certain of the larger groups, such as the lungfishes and the Actinopterygia, and in carrying their history back to the early Devonian. In his classic memoir on the Palæoniscidæ, he showed on evidence that is now accepted as incontrovertible—but which none the less was not at all evident before he took up these obscure fossils—that these fishes are related to the sturgeons, especially to such forms as *Polyodon*, and not, as previously believed, to the gar pikes. This conclusion was of far-reaching importance, leading to a modification of many other ideas of the inter-relationships of the groups of fishes. The flattened, compressed Platysomidæ, he proved, are a specialized branch of the Palæoniscidæ; and he showed conclusively that *Cheirolepis* was a primitive ganoid, not an Acanthodian, and thus traced back the history of the acanthopterygian fishes almost as far back as that of any other group. He was the first to prove that the Devonian *Dipterus* was a lungfish, and thus he extended the geological history of this group. He gave us a revised study of the Arthrodire, *Coccosteus*, on which one or two restorations by other writers were subsequently based; and it was he who first clearly defined the characters of *Homosteus* and of *Phlyctænaspis*. He was the first to bring together our scattered knowledge of *Pterichthys* and to give a restoration of this form; and he, also, worked out the anatomy of that primitive type, *Drepanaspis*. To Traquair also must be credited whatever knowledge we possess of those extraordinary forms *Thelodus* and *Lanarkia*, which gave us the first conception of the appearance and the structure of the earliest known vertebrates. Dr. Traquair also devoted considerable time to preparing monographs of the fishes of the Old Red Sandstone. These were published by the Paleontographical Society, and appeared in parts, as ready; these, unfortunately, are left unfinished.

These are only a few of the more far-reaching studies of Dr. Traquair which our limited space allows us to mention, but there was hardly a field of paleozoic ichthyology which he did not touch, and, as was well said by one of his biographers, he touched nothing that he did not adorn.

Personally, Dr. Traquair was a most charming man. In 1909 the writer had the privilege of seeing him almost daily at the museum or in his home. He was quiet and reserved in bearing, but he possessed a fund of humor that was all the more surprising because, on account of his quiet manner, it was not at first expected. One could not be with him many days without seeing that the man was far greater than his works. He had a deep appreciation for the beauties of nature. He had a great love for Scottish history and knew the legends concerning every name and place, whether it was *Mons Meg* or Holyrood Abbey. He was a most charming host, and the memory long lingers of having seen him the center of a circle at an afternoon tea, when he was the life of the whole company. He was very fond of flowers, and the artistically laid out rectangular garden, sloping down from the rear of the house at Colinton, near Edinburgh, gave him great delight, and he talked with genuine pleasure of its every plant. He was a student of modern languages, which were his hobby, and it was with amazement that one who knew only his work on fossil fishes heard him discourse, at length, on words and their history. He used to spend most of his vacations in Germany because of his great love for the language and for the ways of German savants; and he spoke the language fluently, and wrote it with a grace that is seldom achieved except in one's mother tongue.

Those who have known Dr. Traquair intimately are deeply grieved to have lost a wise and lovable friend.

L. Hussakof
American Museum of Natural History

JOHN SHAW BILLINGS

The New York Library Club has adopted the following resolution:

Resolved, That on the death of John Shaw Billings, The New York Library Club desires to record its grateful recognition of the great part which he played in the development of the library service of New York City and of the United States.

While Dr. Billings gained distinction in the profession of his first choice in medical service during the Civil War, in the organization of the U. S. Marine Hospital Service and of the Johns Hopkins Hospital, as director of the University of Pennsylvania Hospital and professor of hygiene in that institution, as expert in charge of the division of vital statistics of the tenth and eleventh censuses, and as a writer upon medical subjects, it is as one of the most eminent members of our own profession that we honor his memory.

Called in 1895 to be director of the newly established New York Public Library, he gave an impetus to the growth of its collections almost without parallel in the history of libraries and ensured their permanent value by making the collections of government publications and periodicals his first object. He was instrumental in the establishment of a remarkable system of branch libraries and planned the unique library building which contains the library's reference collections and is the center of its circulation department. As members of this club we will honor Dr. Billings as the most distinguished of all those who have served the library interests of this community.

As librarians, however, we will remember also his remarkable achievements as librarian of the Surgeon General's Office, in the development of the largest medical library in the world, in the publication of the most important of medical bibliographies, the "Index Catalogue," as well as the most useful, the "Index medicus," and in the inauguration of a national library service.

And as bibliographers we will remember also his services as delegate of the United States to the congress held in London in 1896 which established the International Catalogue of Scientific Literature.

He was a member of this club and its president in the year 1900, a member of the American Library Association and its president in the year 1902, a member of many learned societies, honored by learned institutions and societies, both at home and in foreign lands.

He gave to his profession the service of a scientist interested in the most common problems, the labors of a specialist with the broadest sympathies.

THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING[1]

The seventh annual report of the president and treasurer of the Carnegie Foundation, which has just appeared, covers the year ended September 30, 1912.

The endowment in the hands of the trustees at that time amounted to approximately $14,000,000, and the income for the year amounted to $676,486, of which $634,497 was expended. From its first pension payment in June, 1906, to the end of the fiscal year September 30, 1912, the foundation has distributed $2,077,814 in retiring allowances to professors and $238,590 in widows' pensions—a total of $2,316,404. In all 429 retiring allowances and 90 widows' pensions have been granted, of which 98 have terminated through death and 23 at the expiration of temporary grants, leaving 315 retiring allowances and 83 widows' pensions in force at the end of the year.

The report of the president, like the former reports, is divided into two parts—the first referring to the current business of the year and dealing with questions more directly pertaining to the administration of the foundation; the second part being devoted to current educational problems of a larger and more general nature.

The first part of the report includes a careful statement of the whole question of pensions for teachers, for government employees and for industrial employees. This statement contains the results of the examination of practically all of the pension systems now in operation anywhere, and leads finally to a discussion of a feasible pension system for the public school teachers of a state. This discussion is particularly needful at this time, since the question of teachers' pensions is a matter under consideration by a number of state legislatures. As the report points out, the bills which have been introduced in the various legislatures almost without exception

[1] Official summary sent by the foundation.

violate fundamental actuarial conditions, and have been framed without study of the essential conditions which must be fulfilled by any adequate pension system. The material brought together in this report, the examples of the failures of pension systems which have occurred—as, for example, that in New South Wales—and the precarious situation in which many state pension systems now stand, make this portion of the report one of great practical value to the authorities of any state contemplating pensions either for teachers or for state employees.

President Pritchett, in arguing finally for some form of contributory pension system for public school teachers, points out clearly the difficulties of the contributory system, the necessity for the most careful actuarial advice and the public nature of the questions which are involved in a distribution of the cost of such a pension system between the state and the teacher.

Following the discussion of these pensions, a complete history of the methods by which the Carnegie Foundation pensions were arrived at is given; the process through which the trustees worked is told in the frankest manner; the difficulties which they encountered and the differences which arose out of the fact that the pensions of the Carnegie Foundation are not contributory, but have come as the result of a free gift, are made clear. The literature on pensions now at the disposal of the foundation is probably the most complete in the statement of such problems that has ever been brought together, and the discussion here made can not fail to be of value to a college, a state or an industrial association which is studying the pension problem; and the pension problem to-day is one of the insistent problems of modern social progress.

The second part of the report is devoted to such subjects as the matter of college entrance requirements, admission to advanced standing, a statement of medical progress, university and college financial reporting, advertising as a factor in education, education and politics, and finally, sham universities.

All of these subjects are discussed in the frank and specific manner which has hitherto been used in these reports. In recounting the extraordinary medical progress of the last five years attention is called to the connection which still exists in the United States between reputable colleges and unworthy medical schools. The lessons of the recent Bulletin on Medical Education in Europe are also brought clearly forward. During the last five years the mortality among unworthy medical schools has been most satisfactory. The number of such schools in the United States has been reduced by about one third and the number of students attending them by about one quarter, and this diminution has occurred in exactly the places where it ought to occur —namely, in the elimination of the unfit.

The section devoted to education and politics discusses not only the recent remarkable changes in the University of Oklahoma, the University of Kentucky and the University of Montana, but also deals with two other tendencies in political life which are profoundly affecting education: first, with the rivalry which comes from competing state institutions, and secondly with the practise inaugurated almost wholly within the last ten years in states where there are no state universities, of subsidizing institutions that are under private control. In a number of states this process has gone on until it has enormously increased the number of privately controlled institutions which share in state appropriations. So marked has this tendency become that the question of state appropriation to education without state control is one which ought now to be frankly and squarely met.

Under sham universities the report deals with conditions such as hold, for example, in the District of Columbia, where commercial enterprises without endowment or facilties are chartered as educational institutions under the loosest conditions, which enable them to appeal to the credulity of ignorant students throughout this and other countries under high-sounding names and under the shelter of charters granted by the general government. A bill now before Congress aims to correct this situation.

The report will be sent upon request to the Carnegie Foundation, 576 Fifth Avenue, New York City.

THE PACIFIC ASSOCIATION OF SCIENTIFIC SOCIETIES

The third annual meeting of the Pacific Association of Scientific Societies will be held at the University of California, Berkeley, April 10–12. The number of constituent societies has increased to fourteen, representing a membership of 2,167.

The Technical Society of the Pacific Coast,
The Cordilleran Section of the Geological Society of America,
The Seismological Society of America,
Pacific Coast Branch of the American Historical Association (not meeting),
The Pacific Slope Association of Economic Entomologists,
Pacific Coast Paleontological Society,
The Philological Society of the Pacific Coast,
The Cooper Ornithological Club,
California Academy of Sciences (not meeting),
Biological Society of the Pacific Coast,
California Section of the American Chemical Society,
Astronomical Society of the Pacific,
The Geographical Society of the Pacific (not meeting),
Puget Sound Section of the American Chemical Society.

The San Francisco Section of the American Mathematical Society will also hold its annual meeting at the University of California on April 12.

The Le Conte Club will hold its annual meeting and dinner at the Faculty Club, Friday evening, April 11.

The General Session of the Pacific Association will be held in California Hall on Saturday evening when an address of welcome will be given by President Benjamin Ide Wheeler, of the University of California. Three papers of general scientific interest will be read by representative members of the constituent societies.

The Southern Pacific, Santa Fe, Western Pacific, Oregon-Washington, Great Northern and Northern Pacific Railroads, have granted the usual convention rates for the states of Nevada, California, Oregon and Washington.

SCIENTIFIC NOTES AND NEWS

The spring meeting of the council of the American Association for the Advancement of Science will be held at the Cosmos Club, Washington, D. C., on the afternoon of Tuesday, April 22, 1913, at 4:45 oclock.

The issue of *Nature* for March 6 contains a portrait of Sir J. J. Thomson, with an appreciation of his contributions to physics by Augusto Righi, professor of experimental physics in the University of Bologna.

To celebrate the seventieth birthday of Dr. Paul Groth, professor of mineralogy in the University of Munich and editor of the *Zeitschrift für Crystallographie,* it is planned to place a bronze bust in the Mineralogical Institute of the University of Munich. Dr. G. Seligmann, of Coblenz on the Rhine, is treasurer of the committee.

The senate of the University of Dublin has approved the conferment of the honorary degree of doctor of science upon Professor A. C. Seward, F.R.S., and Professor the Hon. R. J. Strutt, F.R.S.

The degree of M.A. has been conferred by a decree of convocation of the University of Oxford on Professor W. H. Perkin, F.R.S., fellow of Magdalen College, the recently elected Waynflete professor of chemistry.

Mr. A. Harker has been nominated to represent the University of Cambridge at the twelfth International Geological Congress to be held in Canada in August next.

The Geological Society of France has awarded its Gaudry medal to Professor Edward Suess, of the University of Vienna.

It is stated in *Nature* that the founder's royal medal of the Royal Geographical Society is not awarded this year, but a casket with a suitable inscription will be presented to Lady Scott, to contain the patron's medal and the special Antarctic medal awarded to her late husband, Captain R. F. Scott, in 1904. The patron's medal has been awarded to the late Dr. E. A. Wilson, of the National Antarctic

expedition, and a gold watch to Lieutenant Campbell, who led the northern party of the same expedition. The Victoria medal is awarded to Colonel S. G. Burrard, F.R.S.; the Gill memorial to Miss Lowthian Bell; the Murchison award to Major H. D. Pearson; the Cuthbert Peek grant to Dr. Felix Oswald; and the Back bequest to Mr. W. S. Barclay.

THE position of chief of the Forest Service, now held by Professor Henry S. Graves, who succeeded Mr. Gifford Pinchot, has been placed under the classified civil service. The position will become vacant only on voluntary resignation or on removal for failure to carry out properly the duties of the office.

THE expedition to explore the regions of the Amazon left Philadelphia for the south on the yacht *Pennsylvania* on March 19. The expedition is being made under the auspices of the University of Pennsylvania Museum, and will extend over a period of three years. The leader of the expedition is Dr. William C. Farrabee, curator of the American section of the museum. The yacht is in command of Dr. J. H. Rowen, a retired officer of the U. S. Navy. The other members of the expedition are: Dr. Franklin B. Church, who will make a special study of tropical diseases, and Mr. Sandy McNabb, a traveler of wide experience.

PROFESSOR W. A. HENRY, emeritus professor of agriculture of the University of Wisconsin and for many years dean of the College of Agriculture, is on his way back from a trip to Panama, Jamaica and Cuba. He will spend some time at his large peach farm near Wallingford, Conn.

THE Cutter lectures on preventive medicine and hygiene will be given at the Harvard Medical School by George C. Whipple, professor of sanitary engineering, Harvard University, on "The Use of Vital Statistics." The dates and subjects are: March 31, "With Truth"; April 2, "With Imagination"; April 5, "With Power."

BEFORE the Geographic Society of Chicago, on March 28, at Fullerton Hall, a lecture was given by Professor Merritt L. Fernald, of Harvard University, the title being "The Mountains and Barrens of Newfoundland and the Gaspé Peninsula."

MR. F. E. MATTHES, of the U. S. Geological Survey, gave a lecture on March 18 before the Appalachian Mountain Club of Boston on "The Glaciers of Mount Rainier." On March 19 he repeated this lecture at Wellesley College. On March 20 he spoke to the classes in civil engineering and mining of the Massachusetts Institute of Technology on "The Sculpture of the Yosemite Valley and the manner in which it is brought out on the Yosemite Map." On March 22 he spoke to the classes in civil engineering, mining and geology of Dartmouth College on the "Delineation of Land Forms as Exemplified by the Map of the Yosemite Valley."

VLADIMIR KARAPETOFF, professor of electrical engineering at Cornell University, will address students at four southern colleges, namely, Clemson College, S. C., on April 2; Georgia School of Technology at Atlanta, on April 4; Alabama Polytechnic Institute in Auburn, on April 7, and University of Tennessee at Knoxville, on April 10. In each of these places he is scheduled for three events: a lecture for electrical students on electrostatic and magnetic circuits, a general address on the development of personality and a lecture-recital on musical expression.

A MEMORIAL window to Ralph Stockman Tarr, late professor of physical geography in Cornell University, who died March 20, 1912, was dedicated in Sage Chapel last week. The window was unveiled by Professor Lawrence Martin, of the University of Wisconsin, formerly an assistant under Professor Tarr. Acting President Crane accepted the memorial on behalf of the university.

DR. IRA VAN GIESON, formerly instructor in pathology in Columbia University, and at one time director of the New York State Pathological Institute, died in New York City on March 24.

DR. PRINCE ALBERT MORROW, the eminent dermatologist of New York City, died on March 17, aged sixty-six years.

Dr. E. G. Ravenstein, who did much to improve cartographical methods in Great Britain, has died at the age of seventy-nine years.

Dr. F. Howitz, formerly professor of gynecology in the University of Copenhagen, has died at the age of eighty-four years.

The deaths are also announced of Professor G. Vassale, who held the chair of general pathology at the University of Modena, and of Professor Albanese, who held the chair of pharmacology at Rome.

The U. S. Civil Service Commission announces examinations towards the end of the month for assistant chemist in the office of public roads at salaries ranging from $1,800 to $2,200; for examiner of surveys in the Forest Service, at salaries of from $1,200 to $1,500, and of preparator of fossils in the Geological Survey, at a salary of $900.

By the recent British insurance act it is provided that one penny per insured person, payable out of the moneys provided by parliament, may be retained by the insurance commissioners to be applied for the purposes of research, and the total sum thus available will at present amount to about £57,000 per annum. While the main concern of this part of the act is to combat tuberculosis, the commissioners have been advised that the money may properly be applied to research in connection with any disease which may affect insured persons.

By the will of Carll H. De Silver, of Brooklyn, the Brooklyn Institute of Arts and Sciences receives $50,000.

The twentieth semi-annual meeting of the Association of Teachers of Mathematics in the Middle States and Maryland was held at the University of Pittsburgh on March 22.

The fifth annual meeting of the Illinois Water Supply Association was held at the University of Illinois on March 11 and 12. The membership of the association is made up of waterworks engineers, superintendents, chemists, and others interested in obtaining and conserving an abundant supply of pure water. The papers read at this meeting covered a wide range of subjects, including the study of deep well drillings in Illinois, sterilization of water by ultra-violet light, filter plants, practical methods of obtaining efficiency in waterworks pumping plants, bacterial examination of water supplies, conditions in small filter plants, appraisal of waterworks properties, fire streams and municipal laboratories. About one hundred and twenty-five members attended the meeting. The officers elected for the next year are: President, C. H. Cobb, superintendent, Kankakee Waterworks; First Vice-president, H. M. Ely, superintendent and manager, Danville Water Company; Second Vice-president, W. J. Spaulding, commissioner of Public Property, Springfield; State Vice-president, V. E. MacDonald, superintendent, Lincoln Water and Light Company, and secretary and treasurer, Professor Edward Bartow, director, State Water Survey.

A room in the Geological Museum of Harvard University has been fitted with cases for twelve relief maps and models which have been recently acquired. One of these is a copy of the model of the Mt. Sentis, on the borders of the Swiss cantons St. Gall and Appenzell. This model was done by Mr. G. C. Curtis, '06, and took first prize at the World's Exposition in Paris in 1900. There is also a relief map of southern New England done by Mr. Edwin E. Howell.

A total working income of approximately $35,000,000 was received by 87 state universities and other state-aided institutions of higher education during the past year, as shown by a bulletin just issued by the United States Bureau of Education. Of this amount the United States government contributed about $5,000,000 and the states $18,000,000. The year's income passed the two million mark in the case of three state universities. The University of Illinois had an income during 1911–12 of $2,363,711; the University of Minnesota, $2,682,499; and the University of Wisconsin, $2,122,297. Cornell University, which is technically a private institution but receives state and federal aid, reported total

receipts of over three million dollars with a net income available for current expenses of about a million and a half. Several other state-aided institutions are in the million-dollar income class. These include the University of Michigan, which had an income of $1,343,057; Ohio State University, with $1,011,571; and the University of California, with $1,711,393. The latter had an additional half million from private benefactions. The state of Iowa supports several institutions of college and university rank with a combined income of over two million dollars. Some of the states are exceedingly generous to their colleges and universities, and in such cases the national government's contribution is only a small fraction of the total. Illinois meets the government's $80,000 with nearly two million dollars from state funds, and there are several other states that are similarly liberal. Most of the states give to higher education a greater sum than they receive from the United States government. On the other hand, a few states depend to a considerable extent upon Uncle Sam's bounty. The state of Delaware provided $22,000 last year for Delaware College, to accompany the $70,000 received from federal funds; in Maryland the state itself furnished $36,000 for the Agricultural College, against $80,000 received from the federal government; New Hampshire's contribution to the State College was $20,955; and the state of Vermont gave only $26,000 out of a total income of $277,815 reported by the state university, while $80,000 was derived from the United States government and $60,958 from private benefactions. In some of the larger state-aided universities, tuition fees from students have become an important factor in the annual income; and others that are to a certain extent public institutions have private benefactions that yield a permanent working revenue. Thus the University of Vermont has considerable endowment; Massachusetts Institute of Technology, though aided somewhat by state and national government, depends for the bulk of its income upon the students' fees and private funds; and Cornell University received nearly half a million from each of three sources, namely, students' fees, productive funds and state appropriations.

UNIVERSITY AND EDUCATIONAL NEWS

The legislature of Missouri, at its biennial session, has appropriated for the support and buildings of the University of Missouri during 1913–14 $1,417,500. Included in this are appropriations of $200,000 towards a library building; $100,000 for a biological laboratory, and $25,000 for a live stock judging pavilion. In addition to the above the Agricultural College, which is a part of the university, receives $142,000. Of this appropriation $50,000 is for hog cholera serum; Agricultural Experiment Station, $30,000; county farm advisers, $25,000; soil experiment fields, $20,000; state soil survey, $12,000, and Corn Growers' Association, $5,000.

Messrs. Andrew W. Mellon and Richard B. Mellon, of Pittsburgh, have announced their purpose to erect on the campus of the University of Pittsburgh a laboratory for the department of industrial research to cost not less than $150,000, to equip the same, and provide a fund of $40,000 per annum for the coming five years for its maintenance. This department of the university is under the immediate care and oversight of Dr. Robert Kennedy Duncan, the well-known leader in industrial research.

A holding trust has been formed in Massachusetts called the Harvard Mutual Foundation. It will receive gifts from those desiring to leave money to Harvard University, pay 5 per cent. interest to the donor or his immediate heirs during their lives, and at their deaths turn over the principal to the university. The fund starts with $250,000. The foundation is controlled by the university, in that its trustees will be named by the corporation, and that body will have a certain voice in the management of the trust. The first trustees are the following: Charles Francis Adams, 2d, '88, treasurer of the university; T. N. Perkins, '91; Arthur Lyman, '83; George U. Crocker, '84; John C. Cobb, Jr., '00; Alexander H. Ladd, '97, and C. H. W. Foster, '81.

In 1909 the Goldsmiths Company gave £50,000 towards the extension of the engineering department in the Central Technical College, London. We learn from *Nature* that the company has now offered to pay the entire cost of the new building, which means an added gift of £37,000. The Goldsmiths' Company has attached the condition that the portion of the capital belonging to the Imperial College of Science and Technology, which will be thus set free, shall be added to the endowment fund, the income being used for higher educational and research work.

The union of the University of Maryland medical department and the Baltimore Medical College is assured, the faculties having agreed on the terms of merger. Members of the faculty of the latter institution will retain their positions in the new school and three of them will become members of the university board of regents.

The amalgamation of the two medical schools in Richmond, Va., has now been consummated. On March 22 the following appointments to the faculty were made by the board of visitors:

Professors

W. G. Christian, anatomy.
W. A. Shepherd, histology and embryology.
Wortley F. Rudd, chemistry.
Alfred L. Gray, physiology.
S. B. Moon, pathology (acting).
Francis W. Upshur, pharmacology and therapeutics.
William S. Gordon, medicine.
McGuire Newton, pediatrics.
Beverly R. Tucker, neurology and psychiatry.
E. P. McGavock, dermatology.
George Ben Johnston, surgery.
Lewis C. Bosher, genito-urinary surgery.
Joseph A. White, ophthalmology.
John Dunn, otology, rhinology and laryngology.
John F. Winn, obstetrics.
Charles R. Robins, gynecology.
Edward McGuire, clinical medicine.
Manfred Call, clinical medicine.
J. Allison Hodges, clinical neurology and psychiatry.
Stuart McGuire, clinical surgery.
Hugh M. Taylor, clinical surgery.

Associate Professors

John W. Brodnax, anatomy.
E. C. L. Miller, chemistry (physiological).
C. Howard Lewis, physiology.
E. Guy Hopkins, pathology (clinical).
Aubrey H. Straus, bacteriology.
Ennion G. Williams, hygiene and public health.
Leslie B. Wiggs, materia medica and pharmacology.
A. G. Brown, medicine (theory and practise).
J. McCaw, Thompkins, medicine (theory and practise).
J. Garnet Nelson, medicine (physical diagnosis).
Dougless van der Hoof, clinical medicine.
St. George T. Grinnan, pediatrics.
Roshier W. Miller, neurology and psychiatry.
G. Paul La Roque, surgery (practise).
James W. Henson, surgery (principles).
A. Murat Willis, surgery (operative).
William W. Dunn, surgery (minor).
W. Loundes Peple, clinical surgery.
William P. Mathews, orthopedic surgery.
R. C. Bryan, genito-urinary surgery.
R. H. Wright, ophthalmology.
S. C. Bowen, otology and rhinology.
Clifton M. Miller, laryngology.
Greer Baughman, obstetrics.
Stuart Michaux, gynecology.

Twenty-seven of these men were formerly connected with University College of Medicine and nineteen with the Medical College of Virginia.

Professor Ira N. Hollis, since 1893 professor of engineering at Harvard University, has accepted the invitation of the trustees of the Worcester Polytechnic Institute to become president of that institution.

Professor W. C. Ruediger, who has been acting dean of the Teachers College at the George Washington University since the death of Dean Hough last September, has been appointed dean.

Professor Jores, of Cologne, has been appointed director of the Institute of Pathology at Marburg.

Professor Lubarsch, of Düsseldorf, has succeeded the deceased Professor Heller as director of the Institute of Pathology at Kiel.

DISCUSSION AND CORRESPONDENCE

THE COMPLEXITY OF THE MICROORGANIC POPULATION OF THE SOIL

DURING the last few years a series of experiments have been carried out in this laboratory by Dr. Hutchinson and myself[1] which we can only interpret as showing that bacteria are not the only active inhabitants of the soil. The results in our view point conclusively to the presence of another group of organisms, detrimental to bacteria and differing from them by their larger size, slower rate of multiplication under soil conditions, and lower power of resistance to heat and antiseptics. They are, therefore, more readily killed than bacteria, and we regard their suppression as an important factor in bringing about the increased bacterial activity known to set in after soil has been partially sterilized or treated in any other way detrimental to active life. Such properties as we could ascertain agree with those of protozoa; we were thus led to look for these organisms in the soil and found numbers of them. We adduced reasons for provisionally identifying the detrimental organisms with the soil protozoa.

Recently several papers have been published in the United States controverting these conclusions. We are not satisfied, however, that the criticisms affect the validity of our arguments, and therefore desire to set out briefly the experimental facts and the conclusions we draw from them. The actual data are to be found in our papers in the *Journal of Agricultural Science;* many of the figures were also presented to the Graduate School of Agriculture at East Lansing last July.

1. We begin with the fact that partial sterilization of soil, *i. e.*, heating it to a temperature of 60° C. or more, or treatment for a short time with vapors of antiseptics such as toluene, causes first a fall and then a great rise in bacterial numbers. The rise sets in soon after the antiseptic has been removed and the soil conditions once more made favorable for bacterial development; it goes on till the numbers far exceed those present in the original soil.

2. Simultaneously there is a considerable increase in the accumulation of ammonia. This sets in as soon as the bacterial numbers begin to rise, and the connection between the two quantities is normally so close as to indicate a causal relationship; the increased ammonia production is, therefore, attributed to the increased numbers of bacteria. There is no disappearance of nitrate; the ammonia is formed from organic nitrogen compounds.

3. The increase in bacterial numbers is the result of improvement in the soil as a medium for bacterial growth and not an improvement in the bacterial flora. Indeed the new flora *per se* is less able to attain high numbers than the old. This is shown by the fact that the old flora when reintroduced into partially sterilized soil attains higher numbers and effects more decomposition than the new flora. Partially sterilized soil *plus* 0.5 per cent. of untreated soil soon contains higher bacterial numbers per gram and accumulates ammonia at a faster rate than partially sterilized soil alone.

4. The improvement in the soil brought about by partial sterilization is permanent; the high bacterial numbers being kept up even for 200 days or more. The improvement, therefore, did not consist in the removal of the products of bacterial activity, because there is much more activity in partially sterilized soil than in untreated soil. Further evidence is afforded by the fact that a second treatment of the soil some months after the first produces little or no effect.

It is evident from (3) and (4) that the factor limiting bacterial numbers in ordinary soils is not bacterial, nor is it any product of bacterial activity, nor does it arise spontaneously in soils.

5. But if some of the untreated soil is introduced into partially sterilized soil the bacterial numbers, after the initial rise (see (3)), begin to fall. The effect is rather variable, but is usually most marked in moist soils that have been well supplied with organic ma-

[1] *Journal of Agricultural Science*, 1909, 3: 111–144; 1912, 5: 27–47, 86–111; 1913, 5: 152–221.

nures; *e. g.*, in dunged soils, greenhouse soils, sewage farm soils, etc. Thus the limiting factor can be reintroduced from untreated soils.

6. Evidence of the action of the limiting factor in untreated soils is obtained by studying the effect of temperature on bacterial numbers. Untreated soils were maintained at 10°, 20°, 30° C., etc., in a well moistened aerated condition, and periodical counts were made of the numbers of bacteria per gram. Rise in temperature rarely caused any increase in bacterial numbers, sometimes it had no action, often it caused a fall. But after the soil was partially sterilized the bacterial numbers showed the normal increase with increasing temperatures. Similar results were obtained by varying the amount of moisture but keeping the temperature constant (20° C.). The bacterial numbers in untreated soil behaved erratically and tended rather to fall than to rise when the conditions were made more favorable to trophic life; on the other hand, in partially sterilized soil, the bacterial numbers steadily increased with increasing moisture content. Again, when untreated soils are stored in the laboratory or glasshouse under varying conditions of temperature and of moisture content the bacterial numbers fluctuate erratically; when partially sterilized soils are thus stored the fluctuations are regular.

7. When the curves obtained in (6) are examined it becomes evident that the limiting factor in the untreated soils is not the *lack* of anything[8] but the *presence of something active.*

8. This factor, as already shown, is put out of action by antiseptics and by heating the soil to 60° C., and once out of action it does not reappear. Less drastic methods of treating the soil put it out for a time, but not permanently: *e. g.*, heating to 50°, rapid drying at 35°, treatment with organic vapors less toxic than toluene (*e. g.*, hexane), incomplete treatment with toluene. In all these cases the rise induced in the bacterial numbers per gram is less in amount than after toluene treatment and is not permanent; the factor sets up again. As a general rule, if the nitrifying organisms are killed, the limiting factor is also extinguished; if they are only temporarily suppressed the factor also is only put out for a time.

9. The properties of the limiting factor are: (*a*) It is active and not a lack of something (see (7)); (*b*) it is not bacterial (see (3) and (4)); (*c*) it is extinguished by heat or poisons and does not reappear if the treatment has sufficed to kill sensitive and non-spore-forming organisms; it may reappear, however, if the treatment has not been sufficient to do this; (*d*) it can be reintroduced into soils from which it has been permanently extinguished by the addition of a little untreated soil; (*e*) it develops more slowly than bacteria and for some time may show little or no effect, then it causes a marked reduction in the numbers of bacteria, and its final effect is out of all proportion to the amount introduced; (*f*) it is favored by conditions favorable to trophic life in the soil.[9]

10. We see no escape from the conclusion that the limiting factor is a living organism. We were, therefore, led to search for organisms not bacteria, slower growing, less resistant and larger. Protozoa naturally suggested themselves. We soon found numbers of ciliates, amœbæ and flagellates and induced Mr. Goodey to study them in detail. This work is still continuing, and promises highly interesting results: some remarkable forms have been picked out, and it is already evident that the zoological survey of the soil will be a prolonged business but will be eminently worth while. The ciliates and amœbæ are killed by partial sterilization. *Whenever they are killed the detrimental factor is found to be put out of action,* the bacterial numbers rise and maintain a high level. Whenever the detrimental factor is not put out of action the protozoa are not killed. To these rules we have found no exception. Some exceptions have been found to the converse proposition,

[8] The soils we used included fertile loams well supplied with organic matter, calcium carbonate, phosphates, etc.

[9] This is dealt with fully in the *Journal of Agricultural Science*, 1912, 5: 27, 86.

i. e., we have sometimes found ciliates and amœbæ in soils in which the detrimental factor had been put out of action, but our present methods do not enable us directly to discriminate between protozoan cysts and active forms, nor to estimate the numbers present, nor, on the other hand, to determine how completely the detrimental factor is put out of action. But in general the parallelism between the detrimental factor and the soil protozoa is so complete that we are justified in provisionally regarding protozoa as the detrimental organisms we have been seeking.

Such is a short statement of the main lines of the work. I have omitted the subsidiary issues: the vain search for bacteriotoxins,[4] for evidence of bacterial stimulus, of improvements in the bacterial flora, etc. The identification of the detrimental organisms with the soil protozoa is provisional only; in the nature of the case a rigid proof would be very difficult even if it were possible.

I now turn to some of the criticisms that have been passed on this work by my American colleagues. Dr. Jacob G. Lipman at the New Jersey Station, in conjunction with Messrs. Blair, Owen and McLean, carried out some experiments,[5] the results of which they consider to be in direct opposition to ours. They added pasteurized and untreated soil infusions respectively to mixtures of dried blood and sterilized soil (heated under a pressure of 1.5 atmospheres of steam). After seven days the pasteurized infusions had induced the formation of no more ammonia than the untreated infusion. These results, they say, "do not bear out Russell and Hutchinson's contention as to the part played by protozoa in depressing the activities of soil bacteria."

[4] This result is not necessarily in contradiction with those obtained by the Bureau of Soils. I understand that Dr. Schreiner's toxin is obtained from badly drained, badly aerated soils deficient in calcium carbonate: our soils, on the other hand, were well drained, well aerated and well supplied with calcium carbonate.

[5] Bull. 248. 1912.

The argument is ingenious, but it does not appear to us to bear on the question. In the first place, soil sterilized by heating under a pressure of 1.5 atmospheres has undergone very considerable decomposition. We have obtained evidence that such highly heated soil is altogether different from normal soil as a medium for the growth of microorganisms. Failure of protozoa to develop in the highly heated soil would be no evidence at all of their inability to develop in ordinary soil. As a matter of fact the nitrifying organisms do not seem to have developed; would Dr. Lipman argue that the results "do not bear out the usual contention as to the part played by the *nitrifying organisms* in the soil"? Secondly, even if the detrimental organisms could develop in highly heated soil they were not given the chance: we have never observed any development in anything like so short a period as seven days, our experiments have always been continued much longer. Lastly, the action of the detrimental organisms is to keep down the *numbers* of bacteria. Now the rate of ammonia production is not necessarily a measure of bacterial numbers and therefore affords no rigid test of the activity of the detrimental organisms.

Dr. G. E. Stone, of the Massachusetts Experiment Station,[6] who has had great experience of soil sterilization and informs us that he has "experimented with practically everything there is in this line," is convinced that protozoa "have little or no part in accounting for the increased number of bacteria in our soils." The evidence is based on some experiments by Messrs. Lodge and Smith. Decoctions were made of untreated soil and of soil heated for 45 minutes to 250° F.; into each of these decoctions soil bacteria were introduced. Greater bacterial development occurred in the decoction of the sterilized soil than in the decoction of the untreated soil. (A subsoil behaved differently.) The authors state that protozoa were absent and that the results must be due to other causes. With this I entirely agree; a decoction of a highly

[6] Twenty-fourth Annual Report, 1912.

heated soil is manifestly very different from a decoction of untreated soil; it contains much larger quantities of dissolved substances and may be expected to behave differently as a medium for bacterial development. The experiment proves conclusively that heating a soil to 250° F. causes decomposition, but I can not see that it helps us to find out what is going on in an unheated soil. The authors go on to say that protozoa are "uncommon in their soils" and "very few forms were found." It would be interesting to find what is the difference between their soil conditions and those at Michigan where Dr. Rahn[7] found protozoa of the same types occurring in numbers of the same order per gram as we find at Rothamsted.

Professor G. T. Moore, writing in SCIENCE,[8] disagrees wholly and absolutely with our work; indeed he thinks that in the tangled maze of microbiological problems "the one fact which does seem to be fairly well established is that the temporary removal from the soil of the protozoa has but little bearing on the problem." We should not feel that we had lived in vain if we had merely been the humble instruments by which such a proposition was established, but again we are not satisfied as to the evidence. Professor Moore asserts that soil protozoa are not killed by toluene, carbon disulphide, etc., but are only temporarily depressed, and after three days their numbers may equal or even exceed those originally present. Never on any occasion have we observed anything of this kind.

In an admirable paper[9] on the effects of heat on the soil Drs. Seaver and Clark attribute to us the claim that the increased productiveness of heated soils is due to the destruction of protozoa. We wish to point out that we have always regarded the destruction of detrimental organisms as only one factor in the case, and have fully recognized the effects of the decomposition brought about by the heat. In order to minimize these decomposition effects we generally treat our soils with vapors of antiseptics rather than by heat, but here also we do not lose sight of the possibility of other changes being induced besides the destruction of life.

Finally, we may be allowed to remind the reader that the adverse effect of our detrimental organisms is on the numbers of bacteria, but that the relationship of bacterial numbers to soil fertility is by no means simple. Fertility is determined by any of the factors capable of limiting plant growth. In some soils it may be the supply of phosphates, of potash, of water that is inadequate; if so, soil bacteria may show little or no connection with fertility. Only when the supply of nitrogen compounds becomes a limiting factor do the soil bacteria come in, and even then the relationship between their numbers and their activity is not quite straightforward. We have traced out this problem in detail in our paper in the *Journal of Agricultural Science*, 1913, p. 152.

We do not underrate the complexity of soil fertility problems and, above all, we do not assert that our destructive organisms are the only things involved in the matter, but we do claim that they are an important factor. Our only hope of getting any further with the complex problems of the soil is to study the factors one at a time. We must not be confused by the circumstances that other factors remain to be studied, nor, on the other hand, must we lose sight of the possibility that these other factors may vitiate some of our experiments.

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TWO ADDITIONS TO THE MAMMALIAN FAUNA OF MICHIGAN

THE northern pine vole, *Microtus pinetorum scalopsoides* (Audubon and Bachman) has apparently not been recorded from Michigan, and up to last year no Michigan specimen had been secured by the museum. In April, 1912, a specimen (No. 42,558, Museum of Natural History, University of Michigan) was taken by W. A. Brotherton, near Rochester, Oak-

[7] *Centr. Bakt. Par.*, 1913, 36: 419–421.

[8] November 8, 1912.

[9] *Biochemical Bulletin*, 1912, 1: 413.

land County, and since that time the writer has examined two specimens from the collection of the Michigan Agricultural College, both of which were secured near East Lansing, one on April 20, 1901, by D. S. Bullock, and the other in August, 1896, by T. L. Hankinson.

Another species apparently new to the Michigan fauna is Richardson's shrew, *Sorex richardsonii* Bachman, a specimen of which, taken at Chatam, Alger County, August 28, 1900, is in the collection of the Michigan Agricultural College. Although Seton[1] includes the northern peninsula in his map of the range of the species, the writer can find no recorded localities nearer than Oneida County, Wisconsin,[2] and the north shore of Lake Superior. Northern Michigan has probably been included in the range because this region formed a part of the "Northwest Territory"; it is not included by Merriam.[3]

The museum is indebted to the U. S. Biological Survey for verifying the identification of the specimens mentioned, and to Professor W. B. Barrows, for the loan of the specimens in the Michigan Agricultural College.

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INTERGLACIAL RECORDS IN NEW YORK

IN Professor H. L. Fairchild's most interesting address on "Pleistocene Geology of New York State" the following statement appears:[1]

> The accepted facts of multiple glaciation in the Mississippi basin coupled with proofs of Prewisconsin drift in Pennsylvania and New Jersey and on Long Island, with accumulating evidences in New England, demands the theoretical acceptance of at least dual glaciation for New York state. But the positive proof, in the field, of a Prewisconsin ice sheet has not been found.

A few years ago, Miss Maury[2] reported an interglacial deposit at the south end of Cayuga Lake, on the west shore between "Taughannock Falls and Frontenac Beach in a small ravine which has cut through one of the delta terraces so common in Cayuga Valley." An exposure gave the following vertical section:

Drift	20 to 30 feet.
Gravel and sand	several inches.
Fossiliferous clay	10 to 15 feet.
Bowlder clay	10 to 15 feet.
Devonian shales	10 feet above lake level.

The lower bowlder clay is thought to represent the Illinoian invasion and is oxidized, indicating a period of exposure to the air and hence of erosion. The lower deposits are peaty and contain a quantity of plant remains. The upper fossiliferous deposits are a slaty blue clay in which mollusks to the number of eighteen species are found in abundance. Twelve of these molluscan species are also found in the interglacial Don beds of Toronto, and the lake in which these animals lived was doubtless contemporaneous with the large Ontarian Lake in which the Don mollusks lived. The thickness of the clay deposits (10–15 feet) indicates a long period of deposition.

In the Watkins Glen-Catatonk Folio of New York,[3] page 26, reference is made to an older drift in Watkins Glen, underlying 100 feet of Wisconsin drift. In the blue clay underlying the drift and overlying a bed of sand and gravel, the leaf of an arctic willow (*Salix reticulatus*) was found. Though this deposit is stated by the authors to have probably been laid down during the advance of the Wisconsin ice sheet, the inference is strong, in view of the Cayuga Lake and the Toronto interglacial deposits, in favor of its being contemporaneous with the Scarboro beds near Toronto which contain cold climate animals and plants, including an undermined willow (*Salix* sp.). The evidence of this Cayuga Lake deposit appears to be quite as conclusive as is that of the Toronto deposits.

[1] "Life Histories of Northern Animals," Vol. II., p. 1107.

[2] Hartley H. T. Jackson, *Bull. Wisconsin Natural History Society*, 1908, pp. 30–31.

[3] "North American Fauna," No. 10, p. 48.

[1] SCIENCE, XXXVII., No. 946, p. 238.

[2] *Journal of Geology*, XVI., pp. 565–567, 1908.

[3] Geologic Atlas, No. 169, 1909.

It is quite probable that well records in western New York will supply additional interglacial records as has been so abundantly done by the well records of Minnesota, Iowa and Ohio. The records in New York state referred to above, while few in number, are still of a character to supply indubitable proof of a Prewisconsin ice invasion in this territory.

During the work of compiling literature relating to the life of postglacial and interglacial deposits, it was observed that little or no attention had been given by New York geologists to the fresh-water life of the ancient lakes of the Champlain substage. The gravels of the Niagara River[4] and certain deposits at Ithaca[5] appear to be the only localities from which life has been definitely reported. Many years ago Hall[6] reported *Unios* and wood from the ridge bordering the south side of Lake Ontario, which marks the shore of the glacial Lake Iroquois. A careful study of this old beach and especially of bays or lagoons behind the beach proper will surely produce results similar to those obtained by Professor Coleman at Toronto.[7]

FRANK COLLINS BAKER

CHICAGO ACADEMY OF SCIENCES

[4] Letson, *Bull. Buf. Soc.*, N. S., VII., pp. 238–252, 1901.

[5] Tarr, *Journ. of Geol.*, XII., p. 79.

[6] "Geology of New York," Part IV.

[7] *Bull. Geol. Soc. Amer.*, XIV., pp. 347–368.

THE PRODUCTION IN KITTENS INOCULATED WITH ENTAMŒBA TETRAGENA OF PATHOLOGICAL FORMS IDENTICAL WITH ENTAMŒBA HISTOLYTICA

TO THE EDITOR OF SCIENCE: Schaudinn stated that the reproduction of *E. histolytica* by sporulation "occurs after a period of lively increase when the conditions of life have deteriorated. In dysentery this is simultaneous with the commencement of healing."

I have been able recently by the rectal inoculation of a succession of kittens with trophozoites of *E. tetragena* to observe during a "period of lively increase" the adolescent trophozoite gradually become reduced in size and to note the production of chromidia in large amount in every individual. This appeared first in the third remove as fine particles in the cytoplasm. In the fourth remove, collections of large particles were seen. The nucleus took on the characters of *E. tetragena*, *i. e.*, prominent karyosome, and at the time of death of the last set of kittens in the fourth remove, typical *tetragena* cysts were seen, but associated with them were forms in which bizarre appearances identical with those figured by Hartmann from Schaudinn's *histolytica* preparations were seen. These are certainly manifestations of pathological cell changes, and represent dislocations of the nucleus, karyorrhexis, karyolysis and extrusion of the nucleus. Many so-called buds were seen, a number of which had become detached from the parent body after the extrusion of chromidia. This budding process seems to be analogous to certain pathological changes in the cytoplasm of mononuclear metazoan cells, for example, in lymphocytes and plasma cells.

The production of budding and other pathological forms identical with the descriptions and drawings of *E. histolytica*, but produced in kittens in a senile precysting race of *E. tetragena* associated with typical *tetragena* cysts indicates almost certainly that *E. histolytica* is a spurious species, having been described by Schaudinn and Craig from senile races of *E. tetragena*.

S. T. DARLING

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INDOOR HUMIDITY

TO THE EDITOR OF SCIENCE: In view of the present-day discussion of the subject of indoor humidity some experiments recently carried out by the writer may be of interest to those who, like himself, have been bothered by the bugbear of the "70 per cent." which seems to be the optimum value according to most authorities.

Inside the casing of the hot-air furnace, and right on the dome or hottest part of the firebox, was placed a cast-iron pan with bottom shaped to fit closely. By a simple automatic device connected with the plumbing this was kept full of water, which was found

to boil vigorously in all but the mildest winter weather. When this was supplemented by a crescent-shaped pan on the "radiator" (also inside the casing) the evaporation reached twenty-five or more gallons a day—this in a house of perhaps 20,000 cubic feet capacity.

A number of observations of the relative humidity were made with a sling psychrometer in both mild and severe weather. The effect of this considerable evaporation was to raise the humidity perhaps 15 per cent. above the 25 per cent. or 30 per cent. which is its winter value in most houses in this climate. When the value exceeded 40 per cent., however, very annoying condensation effects were noticeable; even the double windows were drenched with water, while, with zero weather outside, the baseboards and furniture of bedrooms which had been cold during the night were wet. At 50 per cent. the condensation became unbearable, even the walls—although built with double air space—being wet. With the humidity at 40 per cent., however—and it seldom exceeded this value with the above mentioned evaporation—no bad effects were noticeable, while it has certainly added very materially to the comfort of indoor living and possibly contributed in securing immunity from colds.

In conclusion it seems to the writer that considerable effort is required to raise the humidity even a few per cent., but that this effort is nevertheless well worth while; also that 40 per cent. is as high a humidity as can be obtained in this climate in winter without annoying condensation effects, even in a house with double walls and double windows, while 70 per cent. would mean the atmosphere of a steam laundry.

L. R. INGERSOLL

MADISON, WIS.

SCIENTIFIC BOOKS

Le problème physiologique du Sommeil. By HENRI PIÉRON. Paris, Masson et Cie. 1913. Pp. xv + 520, six figures in text.

This volume makes a notable contribution to the large literature bearing upon the nature and cause of sleep. That the subject is treated in a comprehensive manner is indicated by the headings of the six parts into which the book is divided, namely, the biology of sleep, under which is included a discussion of related conditions in plants and animals; the physiological phenomena characteristic of sleep, the treatment here being limited to the characteristic sleep in man and the mammalia; states analogous to sleep, including such conditions as coma, narcosis, the action of hypnotics, hypnotic and electrical sleep and hibernation; experimental observations upon the factors of sleep; theories of sleep, and lastly a summary of the present state of the problem together with an outline of his own views upon the subject. The bibliographical and critical part of the book seems to be complete and well done. The author quotes a very extensive literature, and, so far as the reviewer can determine from his own knowledge of the subject, the material referred to has been treated with great fairness to the authors concerned. In fact the impartiality and completeness shown in the presentation of the numerous facts and theories ought to make the book an especially valuable source of information for all who are interested in the subject.

Outside this feature interest attaches chiefly to the experimental contributions made by the author and to the theory which he is led to adopt. His own work, done in collaboration with Legendre, consisted mainly of a study of the toxines produced in dogs kept from sleep during periods varying from 30 to 500 hours. In these animals he obtained evidence of the production of a hypnotoxine which he was able to detect in the blood, brain and cerebrospinal liquid. Incomplete efforts made to isolate this body indicated that it is not dialysable, that it is destroyed by heating to 65° C. and that it is precipitable by alcohol and can be redissolved in water. In the animals subjected to insomnia histological examination demonstrated that there was a distinct degenerative change in the cortex of the prefrontal region. The cells were diminished in

size, the nuclei showed displacement and as regards the Nissl granules there was a condition of chromatolysis or achromatosis more or less complete. When the serum or cerebrospinal liquid from one of these animals was injected into the fourth ventricle of a normal dog this latter animal in a short time gave evidence of somnolence, more or less marked, and upon histological examination showed in the cerebral cortex degenerative changes of the same character as those described for the animal suffering from insomnia. On the basis of these and similar observations the author believes that he has demonstrated the formation during the waking condition of a toxin which may be supposed to have a direct effect in the production of natural sleep. As it accumulates it provokes a condition of fatigue or diminished irritability in the sensory-motor apparatus of the central nervous system, which under the usual conditions may pass into normal sleep. In cases of prolonged insomnia the greater accumulation of the toxine may lead to the production of distinct lesions in the cortical cells and finally to death. When the author comes to apply this idea to an explanation of the mechanism of the daily sleep he encounters a number of theoretical objections which are enumerated and discussed with commendable frankness. The fact that seems to him to be the most difficult to harmonize with his theory is the abruptness with which sleep may appear and disappear. On his view of a gradual intoxication of the nerve cells he admits that there should be a progressive development of somnolence as the toxine gradually depresses the activity of the nerve cells. In view of this difficulty he feels obliged to call upon a secondary hypothesis, suggested by the general views of Brown-Séquard, according to which the hypnotoxine under usual conditions does not paralyze or inhibit the cortical cells directly, but exerts its action indirectly by putting into play an inhibitory nervous mechanism of unknown nature which suspends reflexly the activity of the cells. The reader who follows the author's presentation of the positive results of his experiments, with an increasing conviction that here at last has been discovered a definite factor destined to throw light upon the causation of this mysterious daily rhythm, is conscious of a distinct feeling of disappointment when he is asked to accept this unattractive hypothesis of an intermediary inhibitory apparatus. One can only conclude that the author has made another addition to the long list of unsatisfactory theories of sleep. However, we must feel grateful to M. Piéron for an apparently very reliable presentation of the difficult literature of the subject, and for the experimental results which indicate that during insomnia a definite toxic material is formed in the body. It is to be hoped that his findings in regard to this hypnotoxine will be corroborated and extended by other observers, although it must be confessed that the experimental procedure involved in the production of long-continued insomnia is of such a character that few investigators are likely to be attracted to the work.

W. H. Howell

The Mosquitoes of North and Central America and the West Indies. By Leland O. Howard, Harrison G. Dyar and Frederick Knab. Volumes 1 and 2. Washington, D. C., Carnegie Institution. 1912. Published January and February, 1913.

Nearly thirty years ago I heard Cobbold, the well-known authority on parasitism, lecture on *Filaria sanguinis-hominis* and its relation to the mosquito. It was a good lecture, and created a profound impression; but we who discussed the marvel at that time little imagined what still remained hidden behind the curtain, the merest corner of which had been lifted. In those days the Culicidæ, whether regarded from the medical or entomological point of view, were supposed to be relatively unimportant. To-day it seems astonishing that we could have been so ignorant, and yet all the work that has been done is very far from exhausting the subject. In April, 1902, Dr. L. O. Howard applied to the Carnegie Institution of Washington for a grant "which should enable the preparation

of a monograph to include all possible information concerning all mosquitoes" of North and Central America and the West Indies. It was at first expected that the work could be completed in three years, and the grants made covered that period. At the end of that time, however, the work was considered still too imperfect to publish, and was continued for several years more with funds derived from other sources. We now have before us only part of the work, namely, the volume covering the subject in a general way, with a discussion of its medical aspects, and the volume of plates. The descriptions of the genera and species, with detailed information as to distribution and other matters, will follow at some later date.

To those who are not specialists in entomological taxonomy, the first volume is of course by far the most interesting and important, though the later parts will contain a larger proportion of original matter, and will bring out most clearly the great advances made in our knowledge of the Culicidæ by the authors. One's first impression on taking up the first volume is that of wonder at the space needed (520 pages) for what is, after all, a general introductory discussion. On perusing the separate chapters, we are inclined to change our attitude, and marvel rather that it has been possible to treat of so many important topics in a single volume. Then again, our first naïve astonishment that so much is known about mosquitoes gives way to a profound sense of the great amount there is yet to learn. The monograph is "complete" in the sense that it apparently includes all the important available information bearing upon its topic, but almost every chapter suggests to the mind of the reader numerous possible interesting researches. Thus the book is one of those live ones which will, as the result of one of its merits, soon become more or less out of date.

Modern science demands the publication of works which are too expensive and of too broad a scope to be, except in rare instances, prepared by a single man. Thus the mosquito monograph, due to three authors, and containing in addition extensive quotations from many others, stands as a type of the scientific monographs (if the word may still be allowed!) of the future. Prepared by men who are thoroughly familiar with the subject, having contributed many more new observations than any others in this country, it is very far from being a mere compilation; yet there has been no hesitation in compiling from the best sources in every case, with full credit given and usually the exact words of the writers cited. All this involves a certain sacrifice of ostensible originality, but it is much to be preferred to the method of many writers of general works, who, on the plea of uniformity of treatment, undertake to discuss subjects they do not understand, and in using other writings make all sorts of blunders. In the present instance the authors distinctly state that they are "entomologists and not physicians or medical investigators," and so the chapters dealing with medical matters "are not the result of original investigation," although it is well known that the senior author is an expert on medical entomology.

Following the Introduction is a chapter headed Early Accounts of Mosquitoes, which includes among other things a long and interesting quotation from Humboldt. The structure of the mosquito is discussed in about 80 pages, including the immature stages as well as the adult. Standard descriptions are quoted from Child, Dimmock, Kellogg, Nuttall and Shipley, Snodgrass, J. W. W. Stephens, Christophers, Raschke, Hurst, Eysell and others; but the original observations of the authors are more interesting than any of these, since they alone know enough species to give a good *comparative* account. So much that is significant appears from the comparative study of the different organs of various Culicidæ, that there is evidently a splendid field for further research along the same lines, especially in reference to the internal organs. When the taxonomic volume appears, it will no doubt be possible for workers in any part of the country to readily and accurately determine the species they may use in such studies.

The habits of mosquitoes, adults and young, are treated in 50 pages, followed by a detailed account of their natural enemies. This last topic is evidently capable of great extension, and it is evident that any intelligent amateur can readily add to what is known by observations in his own locality. The relation of mosquitoes to man occupies about 260 pages, covering both theoretical and practical aspects. The very clear and well written, but not in the least sensational, accounts of the discovery of the connection between mosquitoes and malaria and yellow fever ought to be reprinted and distributed broadcast over the country. Some bulletins of the Department of Agriculture give useful practical information about mosquitoes and disease, and there are various other more or less accessible publications dealing with these matters; but would it not be a good thing if the plain, unvarnished, historical account of the work of Manson, Ross, Grassi, Finlay, Reed, Carroll and Lazear (and we should like to add portraits of these men) could be sent, in the form of a pamphlet, to every school in North America? We offer the suggestion to Mr. Carnegie. To this account might be added the words of the authors, who after describing brilliant anti-malarial work in foreign countries, are obliged to say: "In the United States, it is sad to relate, almost nothing has been done in the way of an active campaign against malaria alone, even in restricted localities. It is true that extensive work has been done against mosquitoes, but in the most of these cases the incentive does not seem to have been to better the health of the people or to stamp out malaria." The volume ends with a bibliography and a very complete index.

The second volume contains 150 beautiful plates, illustrating the structural characters of the eggs, larvæ, pupæ and adults. In a work otherwise characterized by such conscientious crediting of all assistance, it is surprising to see no reference to the artist or artists of the plates; doubtless this information will be given in the next volume.[1] We note that in the names of species, no attempt is made to alter the terminations of adjectival specific names to make them agree in gender with the names of the genera to which they are referred. T. D. A. Cockerell

University of Colorado

[1] I have since learned that the drawings of whole larvæ and the detail drawings of larvæ (plates 86–131) are by Mr. Knab, part of the latter inked in by Miss Mary Carmody. The male genitalia are drawn by Miss Carmody; the eggs (plates 146–147) are by Miss E. G. Mitchell. The photograph of *Anopheles* wings is by Mr. H. S. Barber.

Trees in Winter: their Study, Planting, Care and Identification. By Albert Francis Blakeslee, Ph.D., Professor of Botany and Director of Summer School, Connecticut Agricultural College, and Chester Deacon Jarvis, Ph.D., Horticulturist, Storrs Experiment Station. Illustrated Octavo, 446 pp. New York, The Macmillan Company. 1913.

About a year ago the writer of this review had the pleasure of making a short notice[1] of Bulletin 69 of the Storrs Agricultural Experiment Station, entitled "New England Trees in Winter" by the authors of the work now under consideration. Then we said "We do not recall any better treatment of our trees than is to be found in this publication." Further use of the bulletin confirms the favorable impression made on its first appearance. We have now a very considerable enlargement and revision of the bulletin in the form of the stout volume whose name appears at the head of this review. In revising the earlier publication the authors have introduced chapters on the structure, life and growth of trees, their propagation, tree planting in the country and the city, how to plant, care, common injuries, control of parasites, insecticides, etc. In these chapters the authors have managed to condense a great deal of valuable information for the general reader, and especially for the owner of a piece of ground on which trees are now growing, or on which the owner wishes to plant trees. Nor do they present the growing of trees merely from the standpoint of utility, although that is sufficiently empha-

[1] Science, March 22, 1912.

sized. We like the opening sentences in Chapter III., and can not refrain from quoting some of them, as follows:

Every citizen in every country is interested, or should be interested, in good scenery. Of the various elements that constitute good scenery or that go to make up our landscape there are none so ornamental nor so indispensable as trees.

In discussions relating to the conservation of our natural resources, therefore, the element of good scenery should always be considered. Since good forests, good farms and good waterways contribute largely to the landscape, the element of good scenery can not easily be separated from many of the commonly recognized natural resources.

Trees have become so much a part of our civilization that it would seem almost impossible to get along without them. What would our homes, our country roads, our city streets, our parks, and our landscape be without them? We all know that trees are beautiful and even necessary in such places, but we can not fully appreciate their value till we have seen the desert.

The value of trees from the economic or commercial standpoint is well understood and can be estimated on the basis of dollars and cents. Their esthetic value and their value from the standpoint of health is not so generally appreciated nor is it so amenable to calculation. We hear a great deal these days about surveys—forest surveys, agricultural surveys and the like. A survey in this sense means an inventory or a stock-taking. It would be interesting to make a survey based upon the landscape wealth of any section or of the whole country. It would be interesting also to compare in such a survey the relative value of the various elements of the landscape. It seems safe to predict that in most sections trees would be credited with a very large proportion of the total wealth.

And again in Chapter IV., we find these suggestive sentences:

When we think of the open country we are reminded of the cool and shady roads, although some country roads are not so alluring as they ought to be. The thought is comforting. On the other hand, when we think of conditions in the city, the hot and dazzling pavements present themselves vividly to our memory. The thought is anything but comforting. Blessed is the city that is well supplied with trees.

The attractiveness of a city depends largely upon its trees. A city without trees can not be attractive, and the more trees within the city limits, the more attractive is the city likely to be.

Passing to the systematic part of the book there is first a general chapter on the identification of trees, with such explanation of terms as will render this work easier for the beginner. Then follow various keys, as (1) a key to genera, (2) keys to the conifers, (3) keys to the various kinds of deciduous trees. These keys refer to full-page descriptions and discussions of the particular species, and on the opposite page is a full-page plate of characteristic illustrations made by "half-tone" process from carefully selected photographs. These descriptions cover habit, bark, twigs, leaves (in evergreens only), buds, fruit, comparisons with other species, distribution, and wood characters. Preceding the descriptive matter is an English name, followed by the scientific name, very properly in a book like this, accompanied by the "authority" for the species. A convenient glossary and a well arranged index complete this useful book. The binders have enclosed the text in a pretty and appropriate cover in keeping with its title.

Charles E. Bessey
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Science and the Human Mind, a Critical and Historical Account of the Development of Natural Knowledge. By William Cecil Dampier Whetham, M.A., F.R.S., Fellow and Tutor of Trinity College, Cambridge, and Catherine Durning Whetham, his wife. New York, Longmans, Green, and Co. 1912. Pp. xii + 304. Price, $1.60 net.

This work consists of an Introduction, and of six chapters on Science in the Ancient World, the Medieval Mind, the Renaissance and its Achievement, the Physics of the Nineteenth Century, the Coming of Evolution, and the Last Stage; of a good bibliography (pp. 287–296), and of a full index. The authors are already known favorably to scientific men by their "A Treatise on the Theory of Solution" and "The Theory of Experimental Electricity"; to the general public by their admirable "The Recent Advance of Physical

Science"; and to students of society by several publications on heredity and eugenics. In other words, they have proven their right to the present undertaking by substantial contributions to at least two distinct fields of research.

It is obvious, of course, that a field so vast can not be covered satisfactorily in a single volume of moderate size. Accepting this limitation as inevitable, and setting aside criticisms which, unmindful of it, one might pass readily, it may be said at once that the effort is remarkably successful. Indeed, I am unacquainted with a better book, particularly in the matter of unexpected suggestiveness (towards the close notably), of equal or briefer compass. I would commend the spirited, sometimes eloquent picture of the medieval mind (pp. 64 f.), the lucid account of Newton (pp. 128 f.), the absorbing tale of the rise of electrical science (pp. 181 f.), the generous tribute to Darwin (pp. 209 f.), and the last chapter (pp. 233 f.), which is, in itself, enough to justify the book. It is a pleasure to meet devotees of "natural knowledge" who not only can write, but evince sane appreciation of humanistic knowledge.

The blots are few. Here and there, especially in the Introduction and on the last page, the authors permit themselves to be betrayed into what I take the liberty to call silly remarks about philosophy and metaphysics. Plainly, their *Wissenschaft* knows not these subjects as *Wissenschaft*. This is the more striking that, in other contexts, they make most ample amends. I mention this, because it punctuates the contrast between themselves and Dr. Th. Merz, with whom they are likely to be compared. They may feel his catholicity, they do not always observe it.

The race-theory, a result of their sociological inquiries, which Mr. and Mrs. Whetham apply to their subject, is one of the fascinating features of the book. "Natural knowledge" has been formulated and developed by the races of northwestern Europe. "It is possible that danger to science, as to society, lies ahead. . . . The dominance of the universal proletariat, which some dread and others acclaim—a proletariat not dissimilar in race to the southern rulers of the Roman Church—may threaten in the future the freedom of enquiry, the fearless exercise of reason, the full development of personality, that form the lifeblood of the northern race and its scientific achievement. . . . If the same race once more gains ascendancy in northern lands, as, by the differential birth-rate and the downward shift of political power, it seems destined to do, it is difficult to believe that scientific results which threaten its prejudices or are not in accord with its ideals will be respected" (pp. 279–80). Darwin was a conspicuous product of the Anglo-Danish and East Anglian folk, who have done most for the progress of science. And so, Mr. Whetham is able to construct a great brief for his own, the East Anglian, university. Nevertheless, I do not see why he should have omitted Macquorn Rankine in reference to the foundation of thermodynamics (p. 179). Nor does his theory, of the mysticism of the northern race, supply the reason why Kelvin "is said to have begun his lectures on physics with the Collect for the day" (p. 158). As a pupil, I may say that Kelvin did so, but because it was the universal custom at Glasgow to open the morning classes with prayer. Nevertheless, I accept the theory, as indeed I must—my paternal ancestors for generations are East Anglians! And yet, I am in doubt; for I still traffic in "speculative philosophy, tossed about by every wind of doctrine" (p. 7). But, it were too hard a test to ask an author to prove his theory on the *corpus vile* of a reviewer of whom he never heard tell. So, once more, I say the book is thoroughly worth while.

R. M. Wenley

Ann Arbor

NOTES ON ENTOMOLOGY

The eleventh volume of the Hampson catalogue of moths has been issued by the British Museum.[1] It deals with four groups—Ente-

[1] "Catalogue of the Lepidoptera Phalænæ in the British Museum," Vol. XI., pp. 689, text figs. 175, pls. CLXXIV.–CXCI., 1912.

lianæ, Stictopterinæ, Sarrothripinæ, and Acontianæ, which include nearly 1,000 species arranged in about 150 genera. They are mostly from tropical countries.

One of the most interesting series of books is that on the fauna of India. A recent volume by Canon Fowler on the beetles is especially attractive because of the general account of the Coleoptera.[3] There is a discussion of the several recent classifications of Coleoptera. the author using, although hardly accepting, three principal divisions, Adephaga, Polycerata and Lamellicornia. The essential characters are given for each family, 103 of which are recognized by Fowler, and a short account of their habits, larvæ, distribution and peculiar forms. A glossary of technical terms used in Coleoptera is also included. In the main part of the work the Indian tiger beetles are fully described and many illustrated in text figures. The part on the Paussidæ includes a summary of their habits, and the little known about their larvæ. The Rhysodidæ and Cupedidæ are also treated in this volume, each with only a few species.

Of all the peculiar termitophilous insects the Histerid beetle recently described by Dr. E. Mjöberg will easily rank as the most remarkable.[3] It is a native, of course, of Australia. There are two tufts or pencils of long, curved hairs arising from each side of the base of the elytra. The termites gather a secretion from these hairs, but it is not known whether the secretion comes from the hairs. The insect is named *Eucurtia paradoxa*.

The value of minute structures in classification is well illustrated by an article on the classification of the bed bugs by Dr. K. Jordan and N. C. Rothschild.[4] They divide the family into three subfamilies on the nature of certain bristles, whether serrate on certain portions or not. The Clinocorinæ includes *Clinocoris* and *Œciacus;* the Cacodminæ includes *Cacodmus, Loxaspis* and *Aphrania,* and the Hæmatosiphoninæ the one genus *Hæmatosiphon.*

The life habits of structurally peculiar insects are apt to be unusual, and Dr. F. Germer has found this true of the Lymexylonidæ.[5] The adult does not feed, but the larvæ apparently feed on a fungus that grows in their burrows. The author illustrates the peculiar structures of antennæ and palpi in various sensory functions.

Dr. A. Dücke has published a revision of the South American genera of bees.[6] He gives a bibliography of South American bees since Dalla Torre's catalogue, a synopsis of the sixty-eight genera known from the region, the geographical distribution of each genus, in some cases a list of the described species, and descriptions of a few new forms.

Professor T. Miyake has given the most complete account, so far, of the life history of a Panorpid.[7] The eggs are deposited in clusters of from six to ten in crevices in the soil. The larva of the Japanese species is similar to that of the European and American species already figured. They probably pass through seven molts, the perforations in the spiracles increasing in number with each molt. The larvæ feed on dead insects. There are two broods in a year. The adults were observed to feed on dead insects and the petals of a flower. None have been observed catching living insects.

Drs. J. Schnabel and H. Dziedzicki have produced a most important work on the

[3] "The Fauna of British India, including Ceylon and Burma," Coleoptera, I., General Introduction, Cicindelidæ and Paussidæ, 529 pp., 240 figs., London, 1912.

[3] "On a New Termitophilous Genus of the Family Histeridæ," *Ent. Tidskrift*, 1912, p. 121–124, 1 plate.

[4] "Notes on the Clinocoridæ, a Family of Rhynchota, with Descriptions of a New Genus and Species," *Novit. Zool.*, 1912, p. 352–356.

[5] "Untersuchungen über die Bau und Lebensweise der Lymexyloniden," *Zeitschr. wiss. zool.* (1), Bd. 101 (1912), pp. 683–785, 2 pls., 31 text figs.

[6] "Die natürlichen Bienengattungen Südamerikas," *Zool. Jahrb.*, Abt. Syst. XXXIV., p. 51–116, 1912.

[7] "The Life History of *Panorpa klugi* McLachlan," *Journ. Coll. Agric. Imp. Univ. Tokyo*, IV., No. 2, pp. 117–139, 2 pls., 1912.

Anthomyidæ.[8] It is a critical revision of the genera of the family, with especial consideration of the male genital apparatus, and all the plates represent hypopygia or lobes of the fifth ventral segment. The authors consider the family in the sense of Girschner, including most of the Muscidæ. In the supplementary part are descriptions of many new species, mostly from Russia.

THE progress of entomology in South America is unfortunately slow, and for this reason we welcome each new elementary treatise from that quarter as an encouragement for the local naturalists to collect and study their insects. A new work of this character is by Dr. C. E. Porter on the Myriopods of Chili.[9] He gives an illustrated account of the structure and habits of myriopods, and follows with an annotated list of the 64 species so far described from Chili. Many of the genera are different from those of our country, and several are peculiar to Chili.

THE anatomical part of the 34th (1912) volume of the *Zoologisches Jahrbücher* is more than ordinarily occupied by entomological articles. Mr. Edw. Schoenemund gives a descriptive and biological study of the larvæ of the three large European Perlas,[10] with notes on the anatomy of the respiratory and digestive systems, and the development of the sexual organs.

Mr. S. Surlov has an article on the salivary glands in the head of some Orthoptera, especially *Mantis*[11] and their relation to similar glands in Myriapoda.

Dr. H. Mammen gives a comprehensive study of the comparative morphology of the stigma in various Hemiptera,[12] both in Heteroptera and Homoptera. He finds that in most Hemiptera there is but one muscle to each stigma whose contraction closes the slit, but in a few forms, two or three muscles occur.

Dr. W. Baunacke has a long article on the sense organs of certain aquatic Hemiptera of the family Nepidæ.[13] These organs on the venter are considered to be organs of orientation.

Mr. E. Foerster gives the results of a study of the comparative anatomy of the sting of various ants,[14] and traces the homologies.

NATHAN BANKS

[8] "Die Anthomyiden," *Abh. Kaiserl. Leop.-Carol., Deutsch. Akad. Naturf.*, XCV. (No. 2), pp. 55–358, 35 pls., 1912.

[9] "Introduccion al estudio de los Miraopodos," Santiago, 1911, 68 pp.

[10] "Zur Biologie und Morphologie einiger Perla-Arten," pp. 1–56, 2 pls.

[11] "Uber die Kopfdrüsen einiger niederen Orthopteren," pp. 97–120, 3 pls.

[12] "Ueber die Morphologie der Heteropteren und Homopteren-stigmen," pp. 121–178, 3 pls.

[13] "Statische Sinnesorgane bei den Nepiden," pp. 179–346, 4 pls.

[14] "Vergleichend-anatomische Untersuchungen über den Stechapparat der Ameisen," pp. 347–380, 2 pls.

SPECIAL ARTICLES

PALMESTHETIC BEATS AND DIFFERENCE TONES[1]

IN publishing the results of my experiments on palmesthetic difference sensibility,[2] I did not take up the question whether the discriminations with which we were dealing were of rates of succession of discrete sensations, or of differences in the characters or quasi-characters of continuous sensations. That this question must be raised is of course obvious, since the vibration-rates of the forks I employed (between four and five hundred vibrations per second), are below the fusion limit as reported by Valentin,[3] von Wittich,[4] Schwaner[5] and others. The results of Preyer,[6]

[1] From the Psychological Laboratory of the Johns Hopkins University.

[2] Dunlap, K., "Palmesthetic Difference Sensibility for Rate," *Amer. Jour. of Physiol.*, XXIX., 108–114.

[3] Valentin, "Ueber die Dauer die Tasteindrücke," *Arch. f. Physiol. Heilk.*, XI., 438.

[4] Von Wittich, "Bemerkungen zu Preyer's Abhandlung über die grenzen des Empfindungsvermögens und Willens," *Pflüger's Archiv*, II., 329.

[5] Schwaner, "Die Prüfung der Hautsensibilität vermittelst Stimgabeln bei gesunden und Kranken," Inaug. Diss., Marburg, 1890.

[6] Preyer, W., "Die Grenzen des Empfindungsvermogens, etc.," 1868, 15.

Lalanne[7] and Mach,[8] giving the fusion limit far below the range I employed, throw doubt on the other results, and make it evident that there is somewhere in the determination a factor which has escaped attention by one group or the other of the experiments, or possibly by both.

The early observations were made with little reckoning of the troublesome psychological problems involved, and with no reference to the possibility which we must at present admit—that vibratory stimuli applied to certain portions of the skin may rouse sensations other than those of pressure, touch, temperature or pain: sensations of vibration, or palmesthetic[9] sensations, as they are provisionally designated. The former point we will consider below; the latter is of prime consequence.

If an observer assumes that when a tuning fork (the stem of it or some attachment to a prong) is applied to the skin the sensation aroused will be either that of mere continuous touch or pressure (we may leave out of account pain and temperature, as being easily discriminated from the other), as when the fork at rest (not vibrating, that is) is applied; or else of the discrete series of touches corresponding to the individual periods of the vibration, his observational problem will be comparatively simple. If the fork is perceived as being in vibration, the judgment will be "*discrete pulses*," or "series of discrete tactual sensation"; if the fork feels as if not vibrating, the judgment will be "*fusion*." In other words, the problem of observation is restricted to the question whether or not the fork can be perceived to be in vibration. This, we may reasonably infer, was actually the problem as understood by a number of the experimenters, and consequently the thresholds of fusion they reported were limited simply by the mechanical capacity of the forks (or whatever serial stimulation devices were employed) to produce a sufficiently intense vibratory stimulus.

When we admit the possibility that the vibration of the fork may produce a sensation which is not identical with the simple touch or pressure sensation, the problem becomes entirely different. It is now a question of determining the point (in rapidity of stimulus) at which the sensation enters, or the point at which it becomes a continuous sensation; or possibly we may have to make both determinations. That there are abundant clinical observations which go to show the existence of a palmesthetic sensibility not identical with touch or pressure, I pointed out in my first paper.

The forks with which I first worked (in the neighborhood of 440 vibrations per second) were too heavy for their length, and the vibration-feeling consequently feeble and of brief duration. I have since secured some forks which are better adapted to the work, being relatively more slender, and have carried on observations with these. They have prongs approximately 8×5.5 mm. in cross section, and 19 cm. long for c (128 per sec.) and 13 cm. long for c′ (256 per sec.). The c² forks of the same cross section, 9 cm. long, are less satisfactory. The forks have been fitted (by our mechanic) with tubular brass extensions to the stems, giving a total length from the crotch of 9.5 cm. The end of the extension is solid, with a diameter of 1 cm. Weights with clamp-screws are fitted to slide on the prongs so that the forks may be tuned from the original c and c′ down to the F and f below, by any required steps.

These forks were prepared primarily for the purpose of determining difference-sensibility in the octaves represented. This work has not been completed, but shows, so far, about the same threshold as was earlier obtained in the middle octave (approximately 10 per cent.). The present report is not concerned with this measure.

We early noticed that beats were palmesthetically perceived, and were as distinct and characteristic as auditory beats. With properly tuned forks, we found differential sensa-

[7] Lalanne, "Sur la durée de la sensation tactile," *C. R. de l'acad. des sci.*, LXXXII., 1314.

[8] Mach, E., *Sitzber. d. Weiner Akad.*, LI., 2, 142.

[9] The term was introduced in German, by Rydel and Seiffer in 1903.

tions, corresponding to auditory difference-tones. In arousing these, the two fork stems were firmly pressed together, and the circular end of one stem pressed lightly against the skin of the border of the palm; or the subject's finger tips were pressed lightly against the fork stem.

Fearing lest the phenomenon might be some peculiarity of the action of the physical couple corresponding to the "objective" difference tone, certain auditory experiments were carried out, as follows. A König resonator was tuned to the difference tone of one of the forks; it of course gave no response when the vibrating forks were not in contact, and it still gave no response when the stems were pressed together. Pressing both stems against a block of resonant wood failed to make the resonator respond, although the wood was brought within a few inches of the orifice of the resonator. A single fork tuned to the difference-tone and resonator, pressed against the wood in this way, evoked a loud response from the resonator, even when the fork was vibrating feebly.

It occurred to me that the point (in the scale of rapidity) at which the beats passed into a differential sensation might give a measure of the lower limit of palmesthetic sensibility, and that in any case the determination of this point was important. Here the difficulties were encountered.

As only an approximate determination was desirable at this juncture, one of the c′ forks was scaled in the steps b, a♯, a, g♯, g, f♯ and f, certified forks being at hand for these rates, giving differences with the other c′ fork of 16, 33 +, 42 +, 56, 64, 78 + and 85 + double vibrations.

In my own case, the determination is fairly certain. The beats are distinctly perceptible down to c′–g (64). At c′–f♯ (78 +) this discreteness begins to pass into a sensation comparable to that of another fork (*i. e.*, a continuous sensation), and at c′–f (85 +) this new sensation becomes unmistakable and definite, the beats entirely disappearing.

With still greater difference, the differential sensation persists, becoming less and less intense, as is the case with the sensations aroused by single forks of increasingly higher pitch.

In the first day's work with W., a graduate student, the results were exactly the same as those obtained from myself and were invariable. A month later his results were radically different. He still observed the differential sensation as like that from a low fork, but claimed that it was a matter of discrete pulses, differing from the beats of smaller differences only in rapidity. In fact, he now claimed that the single-fork stimuli, even from the 512 fork, gave series of discrete sensations, and further claimed that the auditory stimulus from the same fork produced the same sort of discrete sensations, corresponding to the air pulses. It should be said that W. is unmusical, but is a good observer.

My own observations fit in quite well with those of W., as regards the palmesthetic sensations, although the auditory sensations (beyond 40 vibrations per second) are always sensibly continuous. With best attention, the palmesthetic sensation (beyond 85 per second), is as continuous as the auditory, but nevertheless at certain other times it seems to be a discontinuous series. In my observations, however, there is a clear indication of the reason for this discrepancy. In one case I am attending to the sensation as it is; and in the other case to the fork thought of as an oscillating body—to the representation of visual or muscular sort—rather than to the actual presented sensation. Such training as my palmesthetic sensibility has received during the greater part of my life has probably been in the way of interpreting the sensations in terms of the vibrations represented as movements of some body; hence, even when I should be attending to the sensation I still incline to attend to the meaning instead. A large number of individuals undoubtedly tend to treat vibration in this way.

In attending to sounds, the interpretative tendency is not so strong, as the conditions are not so conducive to training in this direction. The special significance of sounds as

indicating oscillatory movement is more remote, and more easily detached from the sensation. This detachment was difficult for W., in the case of the tuning fork, because it was for him principally an instrument for the inscribing of curves for time-measurement: the sound of the fork signified its motion in space, and the intensity signified the amplitude of the sinusoidal line it could trace. This observation was made by W. and reported in practically the words I have used.

The results of observations made by several other subjects give about the same threshold as my own observations. One graduate student, J., perceived no beats at c′–g♯ (56), obtaining perfect fusion at that point, although in auditory experiments the fusion was not complete until 64 was reached. This subject at no time had tendency to confuse the sensation and the motion. He is quite musical.

Another graduate student, B., reported that he was constantly troubled by the "visualization" of the tuning-fork curve. He perceived clearly the discreteness of the beats up to c′–f♯ (78+), but beyond that point was unable to decide whether the sensation was or was not continuous.

D., an undergraduate student with previous training in palmesthetic work, and in discrimination of rates and in certain other sorts of psychological observation, obtained clear fusion at c′–f♯ (78¼) and undoubted discreteness at c′–a (42⅝). Between these points, there was doubt, and variation in his judgments.

It should be noted that the differential sensation (above about 80) is perceived as exactly like that due to the addition of a third fork, even by subjects who judge it to be a matter of discrete phases. The problem is, therefore, not to decide as to the character of the differential sensation merely, but concerns any vibration of the same rate.

The differential, when faint, may be made perceptible in a way quite similar to that in which the auditory differential is brought out, namely, by stimulating with the lower of the two forks alone for a moment, and then adding the higher; the resultant drop in the pitch of the clang is paralleled by the corresponding change in the felt vibration.

In the tests described herein, the forks were not audible, they being weakly excited, and used at a sufficient distance from the subject's head—at arm's length. In fact, they were scarcely audible when brought up to half the distance from the head.

After making these observations, I am compelled to view with suspicion the results of any simple observations on the threshold of discreteness and fusion in the palmesthetic or haphic realms (and, indeed, in the auditory realm also). I include my own observations in this suspicion, along with others, for while I may say that my observations have been very careful, they can not do more than establish a presumption. Mere observation ("introspection" in the sense of the word now happily becoming obsolete) is productive of no certain results; the measurements I have been describing are excellent vehicles for the demonstration of the fact, and I strongly recommend them to any one who is inclined to rely on the results of simple observation. These observations are not experimental in the proper sense of the word; but fortunately it is possible to apply experimental methods to the problem upon which they bear.

The palmesthetic difference sensation can not be wholly without significance for the theory of auditory perception. Although I have a bias against the "telephone" theory, I must admit that the perception of a difference in vibration rate by dermal or subdermal nerves, and the detection of a differential rate by these same nerves, seems to support strongly the assumption that differences in pitch of sound are not essentially connected with differences in peripheral nervous elements, but that the same cochlear nerve terminations may mediate different pitches, and the same pitch be mediated by different terminations.

Knight Dunlap

ECHINODERM HYBRIDIZATION

It is my purpose to call attention in this note to certain facts, the consideration of which may do something toward bringing

order out of the apparent confusion in which the subject of Echinoderm hybridization is involved.

I may preface my remarks by saying that actually no confusion exists. The apparent confusion is the result of too narrow and restricted a view of the facts, but the student of genetics whose attention has not been called in detail to the matter has no means of realizing that this is true.

In at least two published papers I have made in substance this statement:

> It is well known that an apparent confusion exists among observations on hybrid Echinoid larvæ, as to whether plutei of a maternal type, a paternal type or of mixed form are derived from certain crosses. Different results have been obtained by different investigators and by the same investigators working in different regions or in the same region in different seasons.

This statement was made after the consideration of the work of Boveri, Driesch, Morgan, Seeliger, Vernon, Doncaster, Herbst, Steinbrück and others, in connection with my own observations, extending at that time over a period of five years, which were based upon some fifteen successful crosses.

If further proof of the truth of the quoted statement be needed we have it in the results of Hagedoorn, who wrote in 1909 on the "Purely Motherly Character of the Hybrids produced from the Eggs of *Strongylocentrotus,*" and of Loeb, King and Moore, who in 1910, after working on the same type of material, in the same region, reached the conclusion that the hybrids show neither a preponderance of paternal nor of maternal influence.

Again, Shearer, De Morgan and Fuchs in 1911 published a "Preliminary Notice on the Experimental Hybridization of Echinoids," based upon three years' study of three species of *Echinus,* in which they state the conclusion "that the inheritance of the late larval characters was invariably maternal." In 1912, after another year's work on the same forms they published in the *Quarterly Journal of Microscopical Science,* Vol. 58,

> To our surprise, however, the behaviour of some of the hybrids has differed greatly this season from that of previous years. In late larval life some of the hybrid crosses have shown as strictly a paternal inheritance as in previous years they have shown a maternal one.

It is perfectly evident then that the observations of these later students confirm the truth which I have been trying to establish from my own work, as well as urging that it had already been established by earlier investigators. I emphasize again then the fact that no actual confusion exists. It has been established again and again that under some conditions we may obtain larvæ of a maternal type with respect to certain characters, under other conditions larvæ of a paternal type and under still other conditions larvæ of a blended type. This is established. We should accept the fact.

The real problem in Echinoderm hybridization is the determination of the conditions under which these various types appear.

Another idea to which I wish to call attention is embodied in a statement in the summary of the Shearer, De Morgan and Fuchs 1911 paper:

> As the result of extensive investigation of the early larval history of our various crosses, we have come to the conclusion that these are too variable to afford any definite evidence of parental influence and especially is this true with regard to the skeleton, heretofore considered the chief index of inheritance.

This generalization from a few crosses should not be applied to all. I am very willing to admit the statement for the Shearer, De Morgan and Fuchs crosses. I can not admit it for some of my own.

In my investigation of the variation of Echinoid plutei I made a prolonged study of the skeleton of *Toxopneustes* plutei. I know what the variations in the skeleton under laboratory conditions are, and I determined these variations before drawing my final conclusions as to the character of the skeleton in hybrids. When the extent and nature of the variations in the skeleton have been determined it may well serve as one of the indices of inheritance in crosses.

Further than this, in proper material, pa-

ternal influence may be demonstrated in stages even younger than the pluteus. I am now able to show definite and clear-cut evidence of such influence in the early gastrula stage. This evidence will soon be published in detail, so I shall give it here only in summary.

The material from which this proof is gained was obtained in February, 1911, while I was working at the temporary station established by the department of marine biology of the Carnegie Institution in Montego Bay, Jamaica, British West Indies. The research involved the investigation of the normal development of *Cidaris tribuloides* and of the hybrids obtained by crosses between *Cidaris, Hipponoë* and *Toxopneustes*.

In its normal development *Cidaris* is unlike the modern Echinoids in that the primary mesenchyme is formed late, the cells arising 23–26 hours after the fertilization of the egg, from the inner end of the archenteron, which has pushed, by this time, well into the blastocœle. No mesenchyme cells appear during the blastula stage. In *Toxopneustes*, as is well known, the primary mesenchyme cells arise about 8 hours after the fertilization of the egg, at the posterior pole of the blastula and have passed into the blastocœle before the beginning of the invagination of the archenteron. A similar condition holds for *Hipponoë*.

In the *Cidaris* ♀ × *Toxopneustes* ♂ and the *Cidaris* ♀ × *Hipponoë* ♂ crosses, gastrulation begins in about 23 hours after fertilization, as in the straight fertilized *Cidaris* eggs, the process not being noticeably hastened by the use of the foreign sperm. The primary mesenchyme appears about one hour later, the cells arising around the base of the then very short archenteron, at the region of the lips of the blastopore.

The influence of the foreign sperm is thus clearly shown in the changed site of mesenchyme formation. Furthermore, it appears ontogenetically earlier in the hybrids than in the normal *Cidaris* larvæ.

In calling attention to these matters I do not wish to disparage in any degree the work being done by Shearer, De Morgan and Fuchs and the other British zoologists who have recently begun work in this field. Their work on the later stages is admirable. I do wish to plead against the acceptance of negative evidence as the basis for a positive generalization concerning the early stages in Echinoid crosses. Well-chosen material may give positive evidence.

DAVID H. TENNENT

SOCIETIES AND ACADEMIES

THE ACADEMY OF SCIENCE OF ST. LOUIS

AT the regular meeting of the Academy on February 3 and 17, the following papers were read:

Dr. C. H. Turner:[1] "Apparent Reversal of the Light Responses of the Common Roach."

Dr. LeRoy McMaster: "The Preparation and Properties of the Ammonium Salts of Some Organic Acids."

Dr. Leo Loeb: "Some Biological Aspects of Tumor Investigation."

Dr. Turner discussed a series of experiments conducted with the common roach (*Periplaneta orientalis*) for the purpose of seeing if a negatively phototropic animal could be trained to refuse to enter a specific dark place; and, if that proved possible, for the additional purpose of obtaining an experimental analysis of the behavior.

The electrical punishment method, devised by Professor Yerkes in his study of the dancing mouse, was used.

The speaker stated that he had trained roaches of both sexes and different ages to avoid a specific dark place, and insisted it was equally as logical to interpret his results by concluding that the roach, by means of associated memory, had learned to avoid a specific dark place, as to term its behavior a reversal of negative phototropism.

Professor McMaster described a method of preparing the neutral ammonium salts of monobasic and dibasic organic acids, by dissolving the acids in absolute alcohol or ether and passing dry ammonium gas into the solution. There easily resulted the neutral ammonium salts of succinic, tartaric, ortho- and meta-phthalic, propionic, isobutyric and benzoic acids. Malonic, malic and cinnamic acid salts resulted with difficulty. Analyses showed the compounds to be neutral.[2]

[1] *Biological Bulletin*, Vol. XXIII., 1912, pp. 371–386.

[2] This paper will appear in the April number of the *American Chemical Journal*.

Dr. Loeb pointed out that Weismann's statement that the somatic cells of Metozoa are mortal is not warranted by the facts, the evidence leading merely to the conclusion that somatic cells can usually not reproduce the whole organism. In 1901 Dr. Loeb himself first announced that facts established through experimental tumor investigation made it very probable that tumor cells are potentially immortal, as much so as Protozoa and germ cells, and a few years later he concluded further that, inasmuch as tumor cells are merely ordinary somatic cells living under special conditions, the proof had been supplied, as far as that can be done, that ordinary somatic cells are potentially immortal. He also pointed out that this conclusion could be still further confirmed by serial transplantations of ordinary tissues in animals of various ages. He began such experiments a number of years ago and is continuing this work now under more favorable conditions.

Experimental tumor investigation has furthermore demonstrated that many somatic cells have a potential power to proliferate which appeared almost unthinkable until recent years, one single epithelial or connective tissue cell being potentially able to produce masses of cells which surpass many times the number of cells composing a whole animal of the same species.

Investigations by M. S. Fleisher, in Dr. Loeb's laboratory, fail to show the definite rhythmic changes attributed to tumors by Bashford and Calkins, and Dr. Loeb thinks that if they exist in the case of other somatic tissues, they are not primary attributes of these tissues, but due to secondary mechanisms.

Professor Nipher stated to the Academy that he had recently obtained results confirming his previous conclusion that the strength of a steel magnet depends upon its electric potential.

G. O. James,
Corresponding Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

The 467th regular meeting of the Anthropological Society of Washington was held in room 43 of the new building of the National Museum at 4:30 P.M., March 18, 1913, the president, Mr. Stetson, in the chair. Dr. John R. Swanton read a paper on "The Creek Confederacy."

After explaining the geographical and linguistic positions of the tribes of the Creek confederacy with the assistance of a map, Dr. Swanton traced the evolution of the confederation from a small nucleus of tribes speaking the Muskogee language to a large association, comprising a number of Hitchiti speaking people, the Alabama, Koasati, some of the Apalachee and Yamasi, part of the Natchez, the Yuchi, and, for a time, some of the Shawnee. He showed that this association was facilitated through the institution of a dual division of towns into white or peace towns and red or war towns, the towns of each division, or "fire," considering each other friends or allies, and having opposing but not warlike relations with the towns of the other "fire." It thus happened that when an outside town or tribe came to be accepted as a "friend" of one of the white or red towns in the confederacy its position with reference to all of the other white and red towns was thus established and it entered into the confederate scheme. The communication of other common features to the new towns also took place, although more slowly. Such features were the "green corn dance" or busk, or perhaps rather the Muskogee form of it, participation in common although irregular councils, and the adoption of Muskogee as the standard language of intercommunication. The actual discontinuance of the proper languages of the various members of the confederacy was, fortunately for the ethnologist, much slower, several of them having persisted down to the present day. Through the progressive adoption of smaller tribes and the practical destruction of some in warfare, a process accelerated by white contact, the Creek confederacy came to be almost the sole representative of eastern Muskhogean culture, and even influenced the culture of the Chickasaw to a marked degree. The great Choctaw body, on the other hand, maintained its cultural independence and was never dominated by the Creeks. In sharp contrast to the Creeks, whose national structure was built up by fitting numerous distantly related tribes into an artificial fraternal scheme, the Choctaw seem to have owed their sense of unity to an actual homogeneity in the Choctaw population, the occupancy of a common area, and the necessity to resist common enemies. They perhaps preserved the simplicity of culture existing among all Muskhogean Indians in times long anterior to the formation of more complicated associations or confederacies.

There was no discussion.

Wm. H. Babcock,
Secretary

SCIENCE

FRIDAY, APRIL 11, 1913

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

GENETICS AND BREEDING[1]

ONE of the primary purposes for which the American Breeders' Association was founded was to bring together on a common ground those who were approaching the problem of the improvement of plants and animals by breeding, on the one hand, from the side of practical breeding, and, on the other hand, from the side of the scientific study of heredity. One of these groups stands as the representative of the art or craft of breeding, and the other as the representative of the science of genetics. That each of these two bodies of men has something to learn from the other there is no doubt. Even with the continued and prosperous existence of such an association as this it is certain that actually there is far from being anything like as extensive a mutual interchange of knowledge and opinion between science and practise in breeding as would appear from every point of view to be desirable.

It will have been perceived by all who have followed my remarks so far that they have been commonplace to the point of utter banality. They constitute a thoroughly bromidic introduction to a conventional treatment of that time-stained and battle-scarred old theme of compulsory oratory, the relation of science and practise. Every one can foresee, with a moment's reflection, just what ought to come next, and next, and on to the end. At the outstart should be set forth the great achievements

[1] Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 44.

Address of the retiring chairman of the Animal Section of the American Breeders' Association at its Columbia, S. C., meeting in January, 1913.

of the science of genetics; then the tremendous possibilities thus opened out to the practical breeder, who in the near future will be able to soar from this scientific foundation to realms of wealth and power in the community hitherto possible only to the predatory classes; nevertheless, in a meek and humble spirit of gratitude engendered by the blessings which have been poured at his feet, he in turn contributes to the great cause of science by placing at the disposal of the geneticist the wonderful stores of experience he has accumulated; at the end should come an impassioned plea for "getting together" for the good of agriculture, humanity and sundry other things, which should, if well done, so titillate the emotions as to send everybody home uplifted, and, in general, determined to lead a better life.

I have sketched this little picture, which, if necessarily impressionistic, is essentially true, only to bring into sharp relief the intellectual junction point, at which we shall alight and change cars. Just because there has been so much perfervid oratory, loose thinking and cheap advertising of the achievements of men and institutions based on the ideal or assumed mutual interrelationship of the science of genetics and the breeders' art, it seems worth while to make a careful objective analysis of the actually existing relations between these adjoining fields of human endeavor. Such an analysis will be attempted in what follows. Specifically the question to which attention is invited is: What essential and fundamental contributions has genetics made to the *practise* of the breeders' art? Or, to put the matter in another way, what particular things does the most highly successful practical animal breeder do now which he did not do, or performed differently, before Mendelism was rediscovered or Darwin wrote?

It is generally agreed that during the past fifteen years there has been a great advance in our knowledge of the fundamental laws of heredity. Indeed, it may fairly be said that more has been gained in this regard within this period than in the entire previous history of this field of knowledge. The new method of investigating heredity which was given by Mendel's work has for the first time made a real analysis of genetic phenomena possible. It was a truly imposing array of organisms and characters which Major Hurst was able to list at the meeting in commemoration of Mendel at Brunn, as comprising those attributes of organisms about the inheritance of which something *definite* is *known*.

There is a very widespread assumption that coincident with this advance in our knowledge of the fundamental laws of inheritance there has been an equal advance in the practical art of breeding. This has perhaps resulted from the somewhat overenthusiastic prophecies of the early Mendelian workers. Many will remember the glittering possibilities set forth to the practical breeders in the early meetings of this association. They were told in effect that at last the key to the genetic riddle had been found; that by the application of these simple Mendelian laws existing races of animals could be brought up to desired ideals with more certainty and despatch than had hitherto been possible, and that new races could be created which would surpass in usefulness anything now existing. There was, of course, an element of truth in all this. But it raised unwarranted hopes in the minds of many laymen. The apparent failure of these prophecies to be realized has probably done real harm to the cause of science in the minds of some practical men—representatives of the class to which in last analysis science must look

for its material support—and very generally has led animal breeders to under-rate the real value of Mendelian investigations.

It is permissible to think that the fundamental error involved was in the assumption we are all inclined to make that any distinct advance in science necessarily means an equally marked and immediate advance in the practise of the associated art or craft. It is extremely difficult for the man of the laboratory or the study, as he takes a broad view of the history of the industrial arts, and sees that great progress there has rested upon fundamental scientific discoveries, to realize that the art of breeding differs essentially in this respect from the industrial arts. The breeding of animals by man for more or less definite purposes goes back to prehistoric times. Practically as soon as primitive man began the domestication of animals he must perforce have begun, in greater or less degree, to control their breeding. Having started thus early, the craft of breeding had attained a relatively high degree of development centuries before any attempt was made to formulate the scientific principles of genetics. As an example may be mentioned the breeding of horses in England. It is customary to think of "stallion laws," aimed at the improvement of the horses of a state, as very modern and American, and an indication of the influence of the science of breeding on the practical craft. But three hundred and seventy odd years ago, in the reign of Henry VIII., there was passed a "bill for the breed of horses," which in its preamble stated that:

> Forasmuch as the generation and breed of good strong horses within this realm extendeth not only to a great help and defence of the same, but also is a great commodity and profit to the inhabitants thereof, which is now much decayed and diminished by reason that, in forests, chases, moors and waste grounds within this realm, little stoned horses and nags of small stature and of little value be not only suffered to pasture thereupon, but also to cover mares feeding there, whereof cometh in manner no profit or commodity.

In order to prevent the multiplication of poor specimens section 2 of this law provided that no uncastrated stallion two years or more old which was under 15 "handfulls" high should be allowed to graze on common or waste land in certain counties. Further it was provided in section 6 that all forests, chases, commons, etc., were to be "driven" at a stated time in the year (just preceding Michaelmas day) and all horses, mares and colts which were not of good quality, or did not promise to become or to produce serviceable animals, were to be killed.

The fact is that the practise of the art of animal breeding, so far from languishing, for want of instruction from the science of genetics, is actually immeasurably in advance of that science. The geneticist who is disposed to think otherwise should visit a great horse, or cattle, or even poultry show, and then permit himself to consider candidly the question whether with all his science he could himself breed, or tell any one else how to produce, *finer* specimens than he will see there. Yet by hypothesis that is exactly what he ought to be able to do, if genetics is to set up as a teacher and guide to the best practical methods of live-stock breeding.

It is capable of abundant historical proof that many years ago, before the beginning of the world movement towards agricultural education, experimentation and the grounding of a science of agriculture in general, there were in existence individual animals (even flocks and herds), and strains of seeds or farm crops which were probably intrinsically as fine, as productive, and generally as excellent as any that we know to-day. Given as intelligent care and feeding as our prize-winning animals

and plants now get, there is every reason to believe that they would have equalled or surpassed our finest specimens of to-day. Some specific examples may be cited. Mr. Geo. A. Scott,[2] of Nashville, Tenn., had in 1863 "a common scrub cow" which produced in one year 1,447½ gallons of milk. Taking the weight of one quart of milk at 2.15 lbs. as sufficiently close for practical purposes, this gives a record of 12,448.5 lbs. of milk for the year. This is a respectable figure even for present standards. Going back a half century earlier we have the record of a Sussex cow[3]: "a cow not of either of the highest improved English breeds—long horns or short horns; but of the proper old Sussex breed." The following record is of her production in five successive years beginning in 1805. I have transposed quarts to pounds by the use of the factor given above—2.15.

	Weeks in Milk	Lbs. of Milk	Lbs. of Butter
First year	48	10,580.2	540
Second year	45½	8,894.6	450
Third year	51½	12,366.8	675
Fourth year	42½	9,070.9	466
Fifth year	48	11,543.4	594

Facts of the same sort are at hand for crops. Justin Ely, Esq., of West Springfield, Mass., in 1816, raised 50 bushels of wheat to the acre. Col. Jas. Valentine, of Hopkinton, raised 128 bushels of "Indian corn" to the acre. Payson Williams, Esq., of Fitchburg, raised 614 bushels of potatoes to the acre, and James Whitton, Esq., of Lee, raised 85 bushels of oats to the acre. The average yield of oats to-day is approximately 36 bushels to the acre. The Maine Agricultural Experiment Station, in its tests of the best commercial varieties of oats procurable in this country and Europe, has never been able to obtain a yield per acre of more than 76 bushels.

I have elsewhere discussed records of egg production in poultry in this connection. From 1836 there is an authentic record of crested Polish fowls producing an average of 175 eggs each per year. This was long before the trapnest had been discovered.

Too much stress, of course, should not be laid on such examples as these. They do not indicate that there has been no advance made by the breeder in the qualities of domesticated animals and plants during the last century. The *average* quality of live stock and of crop plants is constantly improving, not only as a result of breeding, but also because of better and more widely disseminated knowledge of how to provide the food and environmental conditions best suited to bring to full expression the potential hereditary capabilities[4] of the individual. I think that such records, however, do fairly indicate that in the practise of the art of breeding there has been no such marked fundamental advance in recent years as there has been in the science of genetics. By empirical methods man has been steadily improving the quality of live stock for centuries past, and long ago a *relatively* high level was reached by the most skillful breeders.

Purely empirical methods are wasteful and slow in operation, but they may attain excellent results. When they are successful it is obviously because at just that point the practise was, by chance, in exact conformity with the underlying principle or law concerned. More generally it may be said that all progressive success of em-

[2] *The Cultivator and Country Gentleman*, Vol. 28, p. 401, 1866.

[3] *Massachusetts Agricultural Repository and Journal*, Vol. IV., No. 4. Cf. also *New England Farmer*, Vol. III., p. 305, 1825.

[4] Consider in this connection the practises of the real expert in making world's records for milk and butter fat production in the seven- and thirty-day advanced registry tests of the Holstein-Friesian breed.

pirical methods depends on a gradual elimination of those operations or practises which do not accord with basic natural laws. In the consideration of the science and practise of breeding this has sometimes been forgotten. It is difficult to remember always that a law of nature may be presumed to have been in operation before its discovery. If Mendel's law represents a real and fundamental law of nature, as certainly appears to be the case in the light of present evidence, it is quite certain that it did not begin operation in A.D. 1900. Whatever of success has been attained during centuries past in the breeding of improved strains of animals and plants, must have been attained by methods and practises which were not violently in discord with Mendelian principles. A nomad Arab may never have heard of the principle of segregation, but none the less he had to reckon with the phenomenon in breeding his horses.

Looking at the matter in this way, the reason is clear why the rediscovery of Mendel's work and the brilliant genetic researches which have followed did not and could not have had any profound revolutionary effect on the *practise* of the animal breeders' art. By years—even centuries—of "trial and error" methods, breeding practise has been brought into rather close conformity with the basic laws of heredity. The discovery of some of these laws by the geneticist could not radically change the breeder's way of attaining results.

What then has the rapidly developing science of genetics done for the breeder and what can it do? Still looking at the matter from the standpoint of the practical animal breeder, it must be agreed, I think, that the chief contribution of recent discoveries in the field of inheritance is that they have brought to light and fairly established certain general principles which enable him in greatly increased measure to understand and interpret his methods and his results.[5] This may seem too mild a statement of the practical value of genetic science to the animal breeder. It undeniably does lack the grandeur of the vision sometimes opened out by the extension lecturer in his zeal to inspire the farmers to better things, and at the same time pave the way to increased appropriations for his institution. But to help one to understand and to interpret is, after all, no mean achievement. It signifies that, with much economy of effort, the successful breeder may dispense with the merely trivial and unessential in his empirical methods, and more directly and uniformly attain the same or a greater measure of success than before. To his less successful brother and the beginner, it means a surer and more rapid guide than the old tradition based on empiricism. It is certain that the young man starting out to-day to be a breeder of fine cattle, of fine horses, of fine chickens, will attain his goal much sooner if he thoroughly understands the meaning of those laws of inheritance associated with the name of Mendel.

The most important general principles which the scientific study of genetics has firmly grounded are, it seems to me, these:

(*a*) That the fundamental basis of all inheritance is to be found in the germinal constitution of the individual rather than

[5] This is of course to be understood as a general statement. There are now a few specific instances, and in time there will be more, where the geneticist has been able to show the breeder precisely how to attain a particular result in breeding commercially for a particular quality, which result he had only hitherto been able to obtain by chance. In no such case, however, so far as I am aware, has the new method been so essentially different from former practise as to be fairly regarded as "revolutionary."

in the body or soma. Those qualities alone are inherited, which are innate in the germ cells, the ova and the spermatozoa. Here only can the breeder find the means with which to accomplish his ends. However interesting theoretically may be those rare and still doubtful cases in which extraordinary influences acting upon the body under the controlled and special conditions of the laboratory may perhaps influence the germ cells through the soma, they have no bearing on the practical conduct of the breeders' craft. Genetics has demonstrated that he may cast aside, for once and all, that mass of tradition and superstition which assumes that influences specifically affecting the body will specifically modify subsequent generations. Has not genetics done breeding a service of great value in freeing it of the sinister influence of "telegony," "saturation," "maternal impressions" and similar sorts of nonsense?

(*b*) That specific characters or groups of characters, in the great majority of cases and perhaps all, are inherited as discrete and definite units. If one mates a pea-combed fowl with a single-combed, all the offspring will have pea-combs. This result occurs whether the pea-combed parent is a Game or a Brahma; whether it is a male or a female; whether it is a strong, vigorous individual, or the sickliest, weakest scrub in the flock. In other words the *kind of bird* it is whose germ cells carry the potentiality to make pea-combs develop in the offspring, so far as we now know has nothing to do with the *specific* result (*i. e.*, the production of a *pea* comb, rather than a single, a rose, or any other kind). Comb form is inherited as a discrete unit uninfluenced by the individual's other attributes. This discovery that characters are inherited as separate units—and no principle of genetics is more firmly grounded than this—gives the breeder a totally new concept of the meaning of "purity" of blood in breeding. We see now that properly (*i. e.*, biologically) one can only speak of an animal as being "pure-bred" when he specifies the particular *character* to which he refers. A chick may be the veriest mongrel in all other respects and yet carry in the germ cells only that potentiality in respect to comb form which leads to the development of a pea-comb. Then however much of a mongrel it may be in respect to all other characters, it is "pure" and "pure-bred" so far as concerns comb. Is it not a contribution of moment to the breeder to have demonstrated that in his breeding operations he may safely and surely deal with individual characters, and groups of correlated characters as units?

(*c*) That in a very great range of cases, perhaps in all—the number of known cases daily grows larger—the Mendelian law of segregation and recombination of characters operates. In the formation of the germ-cells of an individual there is a sorting out or segregation of the hereditary characteristics contributed by the father and the mother and a readjustment of these into all of the combinations, both old and new, which are mathematically possible. What may be the precise cellular mechanism or basis of this wonderful process is not altogether certain, but the phenomenon itself is as certain as the phenomenon of gravitation. It operates as well in regard to the minutest heritable differences in the pedigreed specimens of the same sub-breed as in the wide differences of true hybridization. Properly understood, it enables the breeder to interpret and weigh the results of his breeding operations, and so intelligently to plan the next steps with a certainty and precision hitherto unattainable. Is not this a real contribution of science to practise?

(*d*) That the germinal bases of heritable unit characters can be changed or altered in any respect, only with the greatest difficulty, if at all. It is, I believe, fair to say that there is at present no critical, unchallenged evidence that any alteration can be produced. This matter has recently been discussed in a most able manner by East.[6] The weight of evidence at present indicates that selection does not act in the manner it was long supposed to, in accordance with Darwin's interpretation. It appears that selection, however stringent or long continued, is powerless to alter in any way the original potentialities of the germinal basis of a unit character. Selection appears to be essentially a process of sorting out from a mixture of heritable variations what is already there, and not a germinally creative or germinally additive process.

So far this discussion has been approached from the standpoint solely of animal breeding. It is perhaps allowable, even before this animal section, to digress for a little and discuss plant breeding. The ultimate objective point of the animal breeder is the same as that of the plant breeder, namely the greatest possible improvement of animals and plants and their adaptation to the needs of man. The practical method of working towards this goal is, however, somewhat different in the two fields. The animal breeder almost exclusively works towards the amelioration of existing fixed and "pure" breeds. Especially among the larger domestic animals such a thing as a *new* breed is brought forward by the breeder only on very rare occasions. Almost all of our existing breeds of horses, cattle, sheep and swine have long histories as "pure breeds," and no new ones are being added now. With smaller animals such as poultry the case is of course somewhat different. There we have no registered pedigrees and, with some difficulty, new breeds may be launched.

[6] *American Naturalist*, 1912.

The plant breeder, on the other hand, makes nearly all of his improvements by the production of new varieties. This he does either by hybridization, actually building up a new type, or by isolation of superior pure-breeding forms from already existing mixtures. He is not hampered by a body of tradition that only the "pure bred" is of any particular value. Almost if not quite every one of the most valuable strains of agricultural plants to-day carries the "bar sinister." To the animal breeder they would be "grades" or "crosses" however gametically pure and only with the greatest difficulty would ever have gained a chance to show their worth.

No one would deny that the systems of registry for live-stock and the exploitation of the "pure-bred" have been of great value in the development of the animal industry of the world. They certainly have; and every day the economic importance of the system becomes greater, for obvious reasons. All systems of pedigree registration operate economically precisely like a monopoly. As such a plan of developing the live-stock industry of a country grows, the more difficult does it become for a *new* creation of the breeder to get a foothold. If it is new, it is by definition not "pure-bred," because if it were "pure-bred" it must belong to one or another of the established breeds. But anything not "pure-bred" has no recognized standing, or market value. Without regard to the merits of the individual the mere fact of pedigree registration adds a definite and not inconsiderable amount to the monetary value of an animal. In last analysis this fact is to-day one of the strongest arguments which can be made to the farmer in favor of keeping "pure-bred" animals.

What has just been said is not intended in any way to criticise, or belittle the importance and value of the "pure-bred" registry system of developing the live-stock industry of the world. I merely wish to point out that when he adopted the system, the animal breeder took upon himself along with the advantages certain very real restrictions to the freedom of his breeding operations, which the plant breeder has escaped. The animal-breeding industry of the world has developed as a system of pedigreed aristocracy. The plant-breeding industry is developing as a democracy. The "social position" of a horse or a cow is primarily determined on the basis of whether it had a grandfather or not. A variety of oats takes its place in the world by virtue of its own inherent qualities, with no questions asked about forebears or the orthodoxy of their marital relations. Both aristocracies and democracies have their advantages and their disadvantages as social systems. These merits and defects are just as real and effective in their operation whether the ultimate vital unit of the system be a man, a cow or an oat plant.

Owing to the essentially different conditions and methods of work which obtain in plant breeding, this field is able to reap more direct benefits of a practical character from the advances which have been made in the science of genetics, than is animal breeding. In the creation of new races by hybridization the plant breeder can and does take Mendelian principles as a direct and immediate guide. He has made Mendelism a working tool of his craft.

To conclude: What I have tried to do in this paper is to discuss the relation between the science of genetics and the practical art of breeding as they actually have developed and now exist. Your attention has been directed to the obvious fact that animal breeding has, without the aid of genetic science, attained an extremely high level of achievement. Empirical methods can only have been successful when they were fundamentally in accord with natural laws, and it is therefore not to be considered surprising that the recent discoveries of world-old genetic laws have not radically modified the successful animal breeders' methods. In pointing out that a scientifically trained geneticist is not as yet an absolutely indispensable necessity on a successful animal breeding farm I have no thought or desire to belittle the importance of the science of genetics. My zeal and enthusiasm for the advance of knowledge in this field know no bounds. This attitude, however, furnishes no reason that the geneticist should delude himself, or by rash statements hold out false hopes to the breeder, as to the immediate practical importance of some of the recent developments in the science of genetics. All knowledge is potentially useful, but the fundamental reason for undertaking and encouraging research in genetics, or anything else, is not because what one gets may be useful, but because it is *knowledge*.

RAYMOND PEARL
MAINE AGRICULTURAL EXPERIMENT STATION

THE METAMORPHOSIS OF THE CARNEGIE FOUNDATION

THAT part—a relatively small part—of the new annual report of the Carnegie Foundation which deals with the affairs of the foundation itself, is significant chiefly as showing that the president of the foundation, at least, has already abandoned most of those principles which at the outset were generally understood to govern the foundation's policy with respect to retiring allowances. It is worth while to recall what some of those principles were.

1. The primary purpose of the pension system was to be, not to relieve deserving and necessitous college teachers in their old age, but to better the profession as a whole, "to attract into it increasing numbers of strong

men"[1] and to increase its "social dignity and stability," by increasing the eventual reward of those who continue long in it and reach professorial rank in institutions of sound educational standards. This was laid down as one of the "two fundamental principles" in the first annual report. President Pritchett therein wrote:

> In the long run, men's personal preference for the work of the teacher . . . can not be depended on to secure an adequate supply of the best men. This fact the older European countries long ago recognized, and in order to secure for the place of teacher the best men, they have sought to dignify the profession of the teacher by the highest social and official honors; and they have sought in addition to strengthen it by larger financial rewards. And inasmuch as the salaries of the teachers can not be made equal to those of outside professions this reward has come, in the main, by the establishment of a system of pensions. . . . In other words, the first and largest ground for the establishment of systems of retiring pensions for teachers has been found in a wish to strengthen the teaching profession.[2]

2. As a necessary consequence of the preceding, a second principle repeatedly enunciated in the earlier reports was that the retiring allowance "should come as a matter of right, not as a charity." President Pritchett wrote in 1906:

> No ambitious and independent professor wishes to find himself in the position of accepting a charity or a favor, and the retiring allowance system simply as a charity has little to commend it. It would unquestionably relieve here and there distress of a most pathetic sort, but, like all other ill-considered charity, it would work harm in other directions. It is essential, in the opinion of the trustees, that the fund shall be so administered as to appeal to the professors in American and Canadian colleges from the standpoint of a right, not from that of charity, to the end that the teacher shall receive his retiring allowance on exactly the same basis as that upon which he receives his active salary, as a part of his academic compensation.

3. One of the purposes especially emphasized in the first report was that of "freshening the work of the colleges themselves by enabling them to put new men into the places of those whom old age or disability has rendered unfit for service."[3]

4. Pensions were to be granted on three grounds, old age, length of service and disability. Sixty-five years was specified as the limit of age and twenty-five years in professorial grades "as the limit of service upon which a pension may be earned." Widows of professors were to receive one half the allowances to which their husbands would have been entitled.

Upon these points the opinions of President Pritchett have by this time singularly changed. It will be convenient, in noting these changes, to take up the points in reverse order.

4. (*a*) The service-pension provisions of the foundation were, as is generally known, abolished without warning in 1909; that is an old story, little creditable to the executive authorities of the foundation, to which it would not now be needful to recur, did not President Pritchett repeat certain aspersions (already made in the fourth report) upon the members of the profession who became entitled to, and accepted, those pensions prior to 1910; and did he not misrepresent the original policy of the foundation in this matter. Dr. Pritchett now writes:

> The service-pension rule was adopted by the trustees under the assumption that but few applications would be made under it, and that these would be in the main applications from men who were disabled for further service. The intention was, in fact, to use the rule as a disability provision. The outcome showed what might have been clearly foreseen at the beginning, that college presidents and college teachers can no more rise above the ordinary appeal of self-interest than other educated and intelligent men. . . . It has been discouraging at times to find men in the early fifties, in the prime of health and strength, applying for pensions upon trivial and selfish grounds in order to escape from teaching.[4]

[1] First report, p. 37.

[2] *Ibid.*, p. 31.

[3] *Ibid.*, p. 7.

[4] Seventh report, pp. 82–84.

This passage is at once a misleading account of the original service-pension policy of the foundation, and a peculiarly discreditable act of injustice to the seventy gentlemen who received service pensions (in "accepted institutions") under the former rules. It is to be supposed that if the trustees had in 1906 the intentions now retrospectively ascribed to them, they had sufficient access to dictionaries of the English language to be able to give some expression to those intentions. But in fact, they gave no hint then, or in the following years, that they meant the service-pension to be subject to any other limitations than those clearly specified in the rules; and they plainly indicated they did *not* regard it as a disability pension, since, in the annual records of retiring allowances granted, three classes have from the first been distinguished—those granted "on basis of age," "on basis of service," and "on basis of disability." What the foundation did was to declare that a certain number of years constituted "the limit of service upon which a pension may be earned," the pension coming then "upon exactly the same basis as" the recipient's "active salary." Having offered pensions to a number of men on these definitely specified terms, President Pritchett now publishes reflections upon them for accepting the pensions upon those terms. It can not even be said (what Dr. Pritchett implies) that the recipients of service pensions had reason to know that they were taking "for their greater comfort pensions that would mean great relief to more needy teachers." For the first report gave assurance that the income was sufficient to provide for all professors in many more institutions than were on the accepted list; and that it was even hoped that after trial "a more generous scale of pensions" than that then in force could be adopted, "either by extending [*sic*] the limit of age or of service, or by increasing the amount of the individual pension."[5]

(*b*) It now becomes evident that, if the future policy of the trustees is to be guided by the views of the president, the old-age pension also is destined to great modification, and probably to abolition. Dr. Pritchett now writes on this as follows:

> The experience of the foundation shows that the minimum age limit should be set higher than sixty-five. . . . Just what age is the best to set as a minimum limit it is difficult to say. The whole matter comes back to *a conception of the pension which is somewhat different from that which we all very naturally entertained at the beginning, that is, that the pension is not intended to assist the man of strong body and mind to get out of teaching at any assigned age, it is to take care of him when his powers fail and he can no longer do his work well.* To raise the limit of age works no hardship to the man who is broken in health at sixty-five. Such a man would be retired on the ground of disability. One places a different ideal before the teacher, moreover, when he suggests *retirement on the ground of approaching weakness rather than on the ground of a definite limit of age.*[6]

Thus the entire system of professorial pensions may be expected soon to be based upon only one—and that the last—of the three grounds originally recognized, viz., disability.

3. There naturally goes with this change an abandonment of the purpose of "freshening" the teaching in the colleges by facilitating the retirement (under the age limit) of men not physically disabled but of impaired efficiency.

> The anticipation of college presidents that inefficient men could be disposed of by a pension has proven another delusion.[7]

2. As the foregoing suggests, Dr. Pritchett has already very nearly come to look upon the foundation over which he presides as essentially eleemosynary in its purpose. With some indirection, yet unmistakably enough, he intimates that, in his opinion, teachers possessing "an adequate or modest income" can not with entire propriety accept pensions. He finds that the teacher does *not* "receive his retiring allowance on exactly the same basis as that

[5] First report, p. 15.

[6] Seventh report, p. 69; italics mine. It should be added that President Pritchett regards the plan of contributory pensions as the ideal one, though he does not definitely urge its adoption by the foundation.

[7] Seventh report, p. 84.

upon which he receives his active salary." President Pritchett is, indeed, not quite able to forget his early insistence upon the principle that the foundation's pensions "come as a right, not as a charity." He therefore repeats this, and straightway unsays it.

> While the trustees have sought, and rightly sought, to have teachers in the accepted institutions feel that the pension is a thing earned and not a charity, nevertheless it ought to be said that the acceptance of it does not stand upon quite the same basis as the acceptance of a salary, nor have teachers appreciated quite fully that their own attitude towards this gift and its use would have its effect upon educational giving and the estimation that the world puts upon the motives and ideals of teachers. The foundation would not in any respect diminish the feeling that the teacher, in an accepted institution, may accept the pension as a right, not as a favor. None the less it remains true that this is a free gift, and that the well-to-do man who accepts it thereby makes it impossible to extend the help of a pension to one who really needs it.[8]

A Carnegie pension, therefore, is hereafter to be regarded as a "right" which is at the same time "a free gift"; it is a thing earned which yet one ought not to accept if one already has a competency—a paradoxical entity indeed. President Pritchett does not thus far indicate that the trustees, before awarding pensions, mean to use the methods of the charity organization society in order to establish the fact of the applicant's poverty; though the past history of the foundation justifies no confidence that the rules will not in time be changed so as to provide for something of this sort. Nor, if poverty is really presupposed, ought the manner of establishment of the fact to be left undetermined. But for the present the question is left "for the individual himself to settle." The individual, however, receives a plain hint that he is expected to settle it only in one way. Thus the basis upon which pensions may, in President Pritchett's view, hereafter legitimately be applied for is not service rendered, but destitution. He would have them go exclusively to aged professors who are also disabled and who "really need" such a "free gift" for their support, and to widows similarly in need.

[8] *Ibid.*, p. 83.

1. All this means, of course, that the purpose which the early statements of the foundation gave as its chief reason for being has now been discarded altogether. This follows both from the particular nature of the changes already made or foreshadowed, and also from the fact, now abundantly evident, that, in general, constant change in its purposes and its rules is the most distinguishing feature of the foundation's conduct. The reward to be expected by the reasonably successful and thrifty member of the teaching profession will be in no degree increased, if the system is put upon the basis which President Pritchett now recommends. The "social dignity" of the profession will be in no way enhanced by the maintenance of a fund for the relief of destitute and disabled professors and their relicts, least of all, if it is to continue to be a feature of the foundation's policy to publish periodic animadversions upon persons who have accepted pensions to which the plain language of the rules seemed to entitle them, and if the annual reports are regularly to contain melancholy reflections on "the darker side of pension administration" and the surprising "selfishness" of many teachers. "Increasing numbers of strong men" are little likely to be attracted into the profession in their twenties by the expectation of receiving a "free gift" at nearly seventy, on condition that they are then incapacitated and without means of support—especially when they know that the corporation promising this gift reserves and frequently exercises the right to disappoint the expectations which it has aroused.

While the new report thus manifests a reversal of the principles originally adopted on these four essential points, it records one change which is more in keeping with those principles than has been the practise heretofore prevailing. Hereafter no new grants are to be made to persons not in "accepted institutions."

Though the relation of cause and effect is not altogether plainly avowed, the probable

reason for all five of these changes of heart is to be sought in the foundation's financial situation. The actuarial calculations upon which the trustees based their original plans have proved far too sanguine. The first report estimated that the average pension under the rules then in force would be less than $1,450. The present general average is $1,677; of those in accepted institutions, about $1,780. If it were not for the obligations assumed towards persons not in accepted institutions, even with this increase the pensions paid to the present number of professors or widows of professors in such institutions would leave a surplus out of the annual income of about $200,000; as it is, there is an accumulation in the past year of some $42,000. The present close approach of the foundation's expenditure to its income is thus chiefly due to the policy of making special grants, hereafter to be abandoned. But even with this charge in process of elimination, the time when claims for pensions, valid under the present rules, will far exceed income is clearly in sight. It was expected in 1906 that an income of $500,000 would maintain an adequate pension system for between 100 and 120 colleges—as many as were thought likely to come upon the accepted list. At present the providing of pensions—with the service-pension abolished—for 72 institutions only, requires an expenditure of $478,440; and it is estimated that "at the end of a generation," if the existing rules should remain unchanged, the claims to pensions *coming from these institutions alone—assuming their faculties to remain stationary in number and the average age of retirement to be sixty-nine*—would call for annual payments of $1,375,000. The foundation's total income, "when the whole of the gifts already made to it by the founder are paid in, will amount to approximately $800,000."[9] Consequently, if the endowment is not increased, the rules for the granting of pensions will inevitably have to be so modified as to reduce greatly the average amount allowed, or the number of valid claims, or both.

In so far, then, as the changes of policy now suggested are designed to meet this future contingency, they may claim the justification of necessity. In attempting to provide pensions, upon the excellent principles originally proposed, for so large a number of institutions, the foundation was attempting a thing impossible with the funds at its disposal. That its impossibility was not foreseen at the outset by the officials of the foundation is amazing. It is true, as President Pritchett constantly remarks, that no complete data bearing upon exactly the foundation's problem were available in 1906. But most of the recently gathered facts with regard to the number, rate of increase of number and of salaries, and age-distribution, of teachers in accepted institutions, upon which facts the present calculations are based, could equally well have been obtained six years earlier; and their indispensableness was then equally obvious. The report of Messrs. Pritchett and Vanderlip[10] upon which the original estimates appear to have been largely based, actually contained no reference to the all-important factor of age-distribution in the case of men not yet of pensionable age. It implied, for example, that the number of professors over 65 in 1905 would approximately indicate the number of the same class in subsequent years. It would be hard to imagine an actuarial error more glaring or more easily avoidable. This error, and the insufficiency of the foundation's endowment for its announced intentions, were clearly pointed out by Professor Cattell in SCIENCE four years ago.

If, then, the foundation (or its president) has within six years abandoned most of its original ideals, and if the university teachers of America have generally lost confidence in the stability of the foundation's policy and the trustworthiness of its promises, this disappointing outcome is the natural consequence of the initial adoption of a program manifestly impossible with the available endowment. The mistake in that program did not consist in its essential principles; it consisted in making the rules completely retroactive; in authorizing special grants; and above all in

[9] *Ibid.*, p. 92.

[10] First report, pp. 10–16.

attempting to provide for too many colleges. President Pritchett in his first report justly remarked:

No one can doubt that the establishment of an effective system of retiring allowances in one hundred institutions will contribute vastly more to the introduction of the retiring-pay principle in American education than the maintenance of a charitable fund for a much larger number of institutions.

But the "one hundred" in this sentence was itself far too large a number. The final result, now definitely foreshadowed, of this original over-estimate seems likely to be that the foundation will in time be nothing more or less than a charitable fund for from seventy-five to one hundred institutions.

A charitable fund, no doubt, will have its uses; it will mean relief from anxiety and distress for a considerable number of worthy and unfortunate people connected with our colleges. But it will render none of those services to "the advancement of teaching" which were once understood to be the chief function of the foundation.

It is, however, possibly even now not too late for a return to first principles—though it, like any other course of action now open to the foundation, would probably involve some hardship. Let the foundation add no more colleges to its "accepted list"; let it, if actuarial analysis should show this to be feasible, announce that all professors who now have legitimate expectations of pensions under the present rules will have those expectations duly realized; or if, as is probable, this is financially impossible, let it provide that at least all now over forty-five or fifty years of age will have their claims met as they mature. But for all others let the present rules be temporarily abrogated. Let the foundation then select carefully a much smaller number of colleges, on the basis of educational standards, geographical situation, and certain other considerations. Let it then, after thorough actuarial study, establish for these institutions a stable system of retiring allowances, *upon the general principles which the foundation first laid down,* with the further requirement that the institution shall contribute a part of each pension, and without requiring absolute cessation of academic activity. These things done, the great initial error would be largely corrected, and the foundation's original purposes would be realized in the measure which its endowment permits.[11] Such a plan would indeed do more not only to establish the "retiring-pay principle," but also to increase the attractiveness, the dignity and the efficiency of the college-teaching profession, than would "the maintenance of a charitable fund for a much larger number of institutions."

It may be, however, that a still more thorough statistical analysis than has yet been made would show that the resources of the foundation will not support such a system for more than an extremely small number of colleges. If this should prove to be the case, there might be defensible grounds for a decision to maintain thereafter, for a larger number, disability-pensions only. But if the foundation should be reduced to this necessity, pensions should be granted for disability (to persons genuinely committed to the teaching profession) at any period of life, or to professors' widows, whatever the age of the husband at the time of death. A disability-pension system is likely to serve the most urgent need precisely in case of break-down or sudden death in middle life, while the family suffering such misfortune still has young children to be educated and before the accumulation of considerable savings has been possible. Furthermore, whatever pensions are provided for should be granted to legitimate applicants without special presumption of poverty. Such a plan, in my opinion, should be the last resort of the foundation; and if adopted it should be frankly recognized as what it is. Yet even it would be preferable to a scheme of the equivocal sort which the president of the foundation now appears to regard with favor.

[11] Another possible solution which merits consideration would be to use the income to aid institutions to establish pension systems. The reasons given (p. 79) for the original rejection of this plan do not seem conclusive.

But the most needful change in the pension policy of the foundation is a cessation of change. The worst possible trait in any system of annuities or insurance is the trait which has hitherto conspicuously characterized the administration of those who have had Mr. Carnegie's great gift in their charge—untrustworthiness. Whatever else it is, a pension system should be a thing which can be depended upon, to which men can adjust their plans with confidence. All its dealings should be marked by an *uberrima fides*. Its rules should be definite and comprehensive; and they should not subsequently have read into them meanings contrary to their natural sense. It is imperative, therefore, that the foundation take the necessary measures to ensure the stability of its policy. It should first of all determine with the utmost care and thoroughness what it is financially able to do. It should thereafter confine its promises within the limits of its possibilities. It should then keep the promises it makes.

ARTHUR O. LOVEJOY

GEORGE HAROLD DREW

GEORGE HAROLD DREW, B.A., of Cambridge, one of the most brilliant of the younger biologists of England, died suddenly on January 30, 1913.

He was the only son of George Samuel Drew, Esq., of Paignton, Devon; and was born on October 23, 1881, and educated at New College, Eastbourne.

He was entrance exhibitioner at Cambridge in 1900 and was elected in June, 1901, to a scholarship in the university, where he paid special attention to the natural sciences and to the more scientific aspects of the medical courses. In 1906 he obtained a scholarship in St. Mary's Hospital, and in 1908 he studied in the Marine Biological Station at Plymouth and was also lecturer in biology in the Plymouth Technical School. In 1910 he was appointed Beit memorial fellow in medical research for the zoological department of cancer, and in 1912 he was elected to the John Lucas Walker studentship for pathology in the University of Cambridge, and on January 1, 1913, he was appointed research associate in the department of marine zoology of the Carnegie Institution of Washington.

He was distinguished not only for his remarkable breadth of knowledge, but even more so for a rare aptitude and insight into methods of research which, had his life been spared, would have led to his name being known among the very few of England's great men of science; but in the springtime of his high promise he passed away and the all but unheeding world has lost a great leader who was to be.

He was the author of only fifteen papers, yet among them are some notable contributions to science.

In coral reef regions naturalists have long been familiar with the vast areas covered with finely divided limestone which has commonly been called "coral mud." In 1910, however, Vaughan stated that these limestone muds appeared to be of chemical origin, and in 1911 Drew discovered that there is in the warm surface waters of the tropical Atlantic a bacillus which is exceedingly abundant and which denitrifies the sea water, thus enabling the dissolved carbon dioxide to combine with the calcium and to form a precipitate of calcium carbonate.

Thus the vast beds of limestone which in coral reef regions are often hundreds of feet in thickness and thousands of square miles in area are formed mainly through the activity of Drew's bacillus.

Moreover, the presence of this denitrifying bacillus in tropical seas accounts for the paucity of sea-weeds in the warm oceans, and the blue color of "coral seas" may in some measure at least be due to the presence of the finely divided particles of calcium carbonate suspended in the water.

Recent studies by Vaughan appear to indicate that oölite is ultimately formed from this precipitated calcium by attraction of the particles to the films of gas bubbles, or to solid nuclei, in the manner described by Linck.

Drew's interest, however, extended to subjects other than those of oceanography; for

his remarkable work in the production of ciliated cysts, and other abnormal growths due to artificial stimulation in *Pecten* and other marine invertebrates led to his being appointed to the Beit fellowship for the study of cancer.

He was, however, far more than a young man whose ability, training and energy inspired confidence respecting his ultimate high position in attainment, for he was an English gentleman, simple in manner, generous in spirit; a charming, brilliant companion, a warm-hearted friend, and above all one whose aim it was to give to the world all that lay within his power to bestow as a servant of the high ideals of civilization.

Alfred G. Mayer

FUR SEAL LEGISLATION

The following letter has been addressed to members of congress under date of March 31, 1913:

The fur seal legislation of the 62d Congress has been left in very unsatisfactory shape. A treaty was entered into on July 7, 1911, by the United States, Great Britain, Japan and Russia, for the suspension of pelagic sealing for fifteen years. This treaty provides protection for the mother seal on her migration and feeding journeys and guarantees the future prosperity of the herd. The treaty was promptly ratified by the Senate, but in the act of August 24, 1912, designed to give effect to this treaty, was included an amendment suspending land sealing—the killing of the superfluous males—for five years. The significant relation of this amendment to the treaty is that the United States agreed to share its land catch with Great Britain and Japan in return for the abandonment by their citizens of the pelagic industry. We are as firmly bound to continue land sealing and share its product as are Great Britain and Japan to prohibit pelagic sealing. Dissatisfaction naturally results from our action. Abrogation of the treaty would be followed by resumption of pelagic sealing, with ultimate destruction of the herd. Even if the treaty be not openly broken, our indifference to our obligations warrants like indifference on the part of our neighbors in enforcing prohibition, leading to illicit open sea sealing.

The final act of the 62d Congress is not less inimical to the welfare of the herd. This was to cut from the Sundry Civil Bill the appropriation for the maintenance of the government force of agents on the fur seal islands, reducing this force to a single care-taker for each island. This is in effect a notice that we have weakened the land defenses of the herd. It is an invitation to the lawless element, largely present among the pelagic sealers, to raid the islands and attack the herd upon its breeding haunts. The natives on the islands are effective defenders only under intelligent and courageous direction. One man can not guard twenty-five miles of shore, for the most part difficult of access through absence of roads and means of transportation. It will not be forgotten that in 1906 Japanese sealers landed upon the rookeries in spite of the active revenue patrol, and were only prevented from inflicting heavy damage upon the herd by the prompt and courageous defense of the resident agents and the natives, a dozen or more of the raiders being killed before the attacks were finally warded off. Reduced to a single care-taker on each island—they are forty miles apart—the island force can make no adequate defense.

The property interests thus being trifled with are of great value, capable of yielding a land catch in 1913 worth not less than $400,000, and this income will grow steadily. To maintain the herd requires protection for its breeding stock on the high seas and upon the breeding grounds. The treaty of July 7, 1911, guarantees the first, the island guards, the second. It is the duty of the 63d Congress to repeal the provision of the law of August 24, 1912, suspending land sealing, and to restore to the appropriation bills the sum necessary to maintain intact the force for island defense.

Respectfully submitted,

David Starr Jordan, *Commissioner in Charge of Investigations, 1896–7.*

George Archibald Clark, *Secretary of Commission, 1896–7, Special Investigator 1909 and 1912.*

THE EUGENICS RECORD OFFICE

The Eugenics Record Office, which was established at Cold Spring Harbor, Long Island, in October, 1910, by Mrs. E. H. Harriman and which has ever since been active in this field, with the additional assistance of Mr.

John D. Rockefeller and others, has recently entered upon a new stage of its development. A board of scientific directors has been organized, comprising Dr. Alexander Graham Bell, chairman; Dr. William H. Welch, professor of pathology, Johns Hopkins University, vice-chairman; Professor Irving Fisher, Yale University; Professor Lewellys F. Barker, of the Johns Hopkins University; Professor E. E. Southard, of Harvard University and director of the Psychopathic Hospital, Boston, and Dr. C. B. Davenport, secretary of the board and resident director. The board met at Cold Spring Harbor on March 21, and organized its work. The aim of the Eugenics Record Office was defined to be as follows. First, to promote researches in eugenics that shall be of utility to the human race. This part of the program includes: the study of America's most effective blood lines; and the methods of securing the preponderance and relative increase of the best strains; the study of the origin of and the best methods of restricting the strains that produce the defective and delinquent classes of the community; the study of the method of inheritance of particular traits; the study of the consequences of the marriages of close kin; the study of miscegenation in the United States; the study, both in this country and abroad, of the family histories of permanent immigrants. Second, to publish the results of these researches. Third, to provide a fireproof building for the preservation of eugenical records, including genealogical works and town-histories. Fourth, to provide an administrative office and staff to carry out the work. The fireproof building that is to form the new home of the office is being rapidly pushed to completion.

The board of scientific directors of the Eugenics Record Office will meet each spring at Cold Spring Harbor to consider the projects most worthy of support during the ensuing year, which begins October first, and it will meet again in November to receive a report of the work of the office in the preceding fiscal year. The resident director has general charge of the plant and its operations and is authorized to ask for and receive, in the name of the board, funds to carry on the work of the office. The board voted in favor of the organization of a Eugenics Research Association, of which a meeting will be called early in June.

THE NATIONAL ACADEMY OF SCIENCES

The National Academy of Sciences will celebrate the fiftieth anniversary of its foundation at the Smithsonian Institution in Washington April 22–24 inclusive. Following is the preliminary program:

Tuesday, April 22

9:30 A.M. Business meeting of the Academy in National Museum.

11:00 A.M. Opening Session, National Museum.
Welcome by the President of the Academy.
Addresses:
"The Relation of Science to Higher Education in America," President Arthur T. Hadley of Yale.
"International Cooperation in Research," Dr. Arthur Schuster, Secretary of the Royal Society of London.

3:00 P.M. Address:
"The Earth and Sun as Magnets," Dr. George E. Hale, Director of the Mount Wilson Solar Observatory.

9:00 P.M. Reception by the Secretary and Regents of the Smithsonian Institution to the Members of the Academy and their Guests at the National Museum.

Wednesday, April 23

10:30 A.M. Morning Session.
Addresses:
"On the Material Basis of Heredity," Dr. Theodor Boveri, University of Würzburg.
"The Structure of the Universe," Dr. J. C. Kapteyn, Director of the Astronomical Laboratory, University of Groningen.

8:30 P.M. Reception at the White House and Presentation of Medals by the President of the United States.

9:00 P.M. Reception by the Trustees of the Carnegie Institution of Washington to the Members of the Academy and Guests.

Thursday, April 24

9:00 A.M. Meeting of the Council at the National Museum.

9:30 A.M. Business meeting of the Academy at the National Museum.
10:00 A.M. During the business meeting of the Academy, opportunity will be given to guests to visit the scientific bureaus and laboratories of Washington. Automobiles will be provided.
2:00 P.M. Excursion to the Home of Washington at Mount Vernon by the U. S. Despatch Boat *Dolphin* (by courtesy of the Secretary of the Navy).
8:00 P.M. Dinner at the New Willard Hotel.

SCIENTIFIC NOTES AND NEWS

The Bruce medal of the Astronomical Society of the Pacific has been awarded to Professor J. C. Kapteyn, of Groningen, for his work on the proper motions of the stars.

It is reported that Professor Czerny, of Heidelberg, will give up next year the direction of the institute for cancer research, which was founded by him.

Dean Russell H. Chittenden, of the Sheffield Scientific School at Yale, is recovering from the effects of a recent operation, but he will be unable to resume his duties for the remainder of the academic year.

By action of the board of regents of the University of Michigan, the name of the Museum of Natural History has been changed to the Museum of Zoology, and Professor Alexander G. Ruthven has been promoted from the position of head curator to that of director.

Dr. Elizabeth Rebecca Laird, Ph.D. (Bryn Mawr, '01), professor of physics at Mount Holyoke College, has been awarded the Sarah Berliner Research Fellowship.

The Yale corporation has voted to appoint Professors Pirsson, Barrell, Lull, Irving and Schuchert as the university's representatives to the twelfth International Geological Congress, to be held in Canada this coming August.

Professors A. G. Christie, R. C. Disque and H. J. Torkelson, of the college of engineering of the University of Wisconsin, will accompany the American Society of Mechanical Engineers on their trip to Europe this summer.

Professor M. M. Metcalf, head of the department of zoology, at Oberlin, has been granted leave of absence for the second semester for travel and scientific research in California. His classes are being continued by Assistant Professors Jones and Buddington.

Dr. R. M. Anderson has been appointed assistant in the department of mammalogy of the American Museum of Natural History. Dr. Anderson will accompany the Stefánsson expedition to the Arctic as zoologist and second in command.

The little power schooner *Polar Bear* sailed for Bering Sea, on April 3, with a party who will make a study of animal and bird life in northern waters. In the party are Mr. Dunbar Lockwood, of Boston; Mr. Samuel Mixter, of Boston, representing the Smithsonian Institution; Mr. W. Sprague Brooks, of Milton, Mass., representing the Museum of Comparative Zoology at Harvard, and Dr. Joseph Dixon, of Berkeley, Cal., representing the Museum of Comparative Zoology at the University of California. The cruise will last six months.

Alfred Vivian, professor of agricultural chemistry, Ohio State University, is making a tour of the world, and is now in India. Professor Vivian will deliver a course of lectures on soil fertility at the agricultural school at Allahabad.

Sir William Osler, regius professor of medicine at Oxford University and delegate of the Oxford University Press, will give an illustrated lecture on "The Oxford University Press," at Harvard University, April 29.

The Weir Mitchell lecture before the College of Physicians of Philadelphia was delivered on Friday evening, April 4, by Dr. H. P. Armsby, director of the Institute of Animal Nutrition of the Pennsylvania State College, on the subject, "Animal Calorimeters and the Study of Nutrition."

On April 2, Professor W. B. Cannon, of the Harvard Medical School, addressed the Rush Medical Society and the undergraduates of the medical school of the University of Pennsyl-

vania on "Some Recent Studies on the Bodily Effects of Fear and Rage."

Dr. H. C. Miller, professor of physics, Case School of Applied Science, lectured under the auspices of the Ohio State University chapter of the Sigma Xi Society on March 7, on the topic "Photographing and Analyzing of Sound Waves." The lecture was accompanied with illustrations.

Dr. Raymond Pearl, of the Maine Agricultural Experiment Station, gave a series of three lectures on genetics at the Ontario Agricultural College, Guelph, Canada, on March 25 and 26.

Arthur H. Blanchard, professor of highway engineering in Columbia University, on March 31, delivered an illustrated lecture on "Highway Engineering in Europe and America" before the Brooklyn Institute of Arts and Sciences.

Dr. A. C. Eycleshymer, of St. Louis University, lectured on March 30 at the University of Illinois on "Growing Old and Attempts to Prevent It." It was one of a series on public health given by authorities in various branches of medicine.

Professor George Grant MacCurdy, of Yale University, recently completed a lecture tour of two weeks in the middle west, the subject being "Ancient Man, His Environment and His Art." He spoke at the Art Museum, Toledo; at Alma College, Michigan; at the Field Museum of Natural History, Chicago; at the University of Missouri, Columbia, and before the Anthropological Society of Washington; also for the Archeological Institute of America at St. Louis, Kansas City, Topeka, Cedar Rapids and Davenport.

Professor Robert Woodworth Prentiss, who had held the chair of mathematics and astronomy in Rutgers College since 1891, died on April 5 at the age of fifty-six years.

Dr. George McClellan, a Philadelphia surgeon, known for his researches in anatomy, died on March 29, aged sixty-four years.

Dr. Adolf Slaby, professor of electrotechnics in the Berlin Technical School and the University of Berlin, known to the general public for his contributions to wireless telegraphy, has died at the age of sixty-four years.

At a meeting of the executive committee of the New York Zoological Society held on February 24, Mr. Niles presented a report with reference to charges against Dr. Charles H. Townsend contained in a report of a majority of the committee of the house of representatives on the expenditures in the Department of Commerce and Labor. After reading and careful consideration of Mr. Niles's report, the executive committee passed the following resolutions:

Resolved, That after a full examination of the proceedings of the House Committee on Expenditures in the Department of Commerce and Labor, and of the report submitted by the minority of the said committee by which it appears that the said committee has never held a single meeting for the purpose of considering the evidence, and that the report made by the chairman was never submitted to the committee for its consideration, and that in the opinion of the minority the report had never been approved by a majority of the committee, that it is the unanimous opinion of the Executive Committee that the honesty and integrity of Dr. Charles H. Townsend have not been impugned in any way; that the recommendations of said Congressional Committee are in no wise justified by the evidence taken by the committee; that the report of the majority of the committee is drawn without any reference to the facts in regard to Dr. Townsend's connection with the matter, and that the attack upon him is unjustifiable, malicious and untruthful, and further

Resolved, That the Executive Committee of the New York Zoological Society does unanimously approve and endorse the report upon the subject prepared by Mr. Niles and the conclusions contained therein.

Madison Grant, *Chairman*
Samuel Thorne
Wm. Pierson Hamilton
W. W. Niles
Henry Fairfield Osborn
Frank K. Sturgis
Percy R. Pyne
Lispenard Stewart

The announcement of the twenty-sixth session of the Marine Biological Laboratory, Woods Hole, Mass., has been issued. The im-

portance of the work there accomplished can be seen from the list of the staff, which is as follows:

Investigation in Zoology and Embryology: Gary N. Calkins, professor of protozoology, Columbia University; E. G. Conklin, professor of zoology, Princeton University; Gilman A. Drew, assistant director, Marine Biological Laboratory; George Lefevre, professor of zoology, University of Missouri; Frank R. Lillie, professor of embryology, University of Chicago; T. H. Morgan, professor of experimental zoology, Columbia University; E. B. Wilson, professor of zoology, Columbia University.

Instruction in Zoology: Caswell Grave, associate professor of zoology, Johns Hopkins University; George A. Baitsell, dean and professor of biology, Central College; Raymond Binford, professor of biology, Guilford College; J. K. Breitenbecker, fellow in zoology, University of Chicago; E. J. Lund, Bruce fellow in zoology, Johns Hopkins University; T. S. Painter, graduate student of zoology, Yale University.

Instruction in Embryology: Gilman A. Drew, assistant director, Marine Biological Laboratory; Lorande L. Woodruff, assistant professor of biology, Yale University; A. L. Treadwell, professor of biology, Vassar College; Robert A. Budington, associate professor of zoology, Oberlin College.

Physiology: Albert P. Mathews, professor of physiological chemistry, University of Chicago; R. S. Lillie, assistant professor of experimental biology, University of Pennsylvania; Harold C. Bradley, assistant professor of physiological chemistry, University of Wisconsin.

Botany: George T. Moore, Engelmann professor of botany, Washington University; George R. Lyman, assistant professor of botany, Dartmouth College; B. M. Duggar, professor of plant physiology, Washington University; Ivey F. Lewis, assistant professor of botany, University of Wisconsin; W. J. Robbins, assistant in plant physiology, Cornell University; R. H. Colley, instructor in botany, Dartmouth College; A. R. Davis, Lockland research fellow, Shaw School of Botany.

Philosophical Aspects of Biology: Edward G. Spaulding, assistant professor of philosophy, Princeton University.

THE twenty-fourth session of the Biological Laboratory of the Brooklyn Institute of Arts and Sciences located at Cold Spring Harbor, New York, will be held during six weeks, beginning Wednesday, June 25. Investigators may make arrangements for using the laboratory at other times of the year but board at the laboratory will not be guaranteed before June 23 nor after August 9. The instruction offered this year consists of the following courses: field zoology by Professor Herbert E. Walter, of Brown University, Dr. A. H. Melander, professor of entomology at the University of Washington, and Dr. C. B. Davenport. A course in bird study will be given by Mrs. Alice Hall Walter, and by Dr. C. E. Ehinger, of the Pennsylvania State Normal School. Comparative anatomy, by Professor Henry S. Pratt, of Haverford College, and Dr. David D. Whitney, of Wesleyan University. Animal bionomics and evolution by Dr. Davenport. Cryptogamic botany by Dr. Harlan H. York, of Brown University, and Dr. W. E. Maneval, of Randolph-Macon College. Plant geography and ecology, by Professor John W. Harshberger, of the University of Pennsylvania. Those who wish to carry on investigation at the laboratory are invited to correspond with one of the above-named instructors. As in the preceding three years a training course for field workers in eugenics, strictly limited in attendance, is offered by Dr. Davenport and Mr. H. H. Laughlin. The announcement of the laboratory for the coming summer may be obtained by addressing the director, Dr. C. B. Davenport, Cold Spring Harbor, Long Island, N. Y.

A STATION for instruction and research in biology will be maintained by the University of Michigan, for the fifth season, as a part of its regular summer session, during the eight weeks from July 1 to August 22. The station is located near the Bogardus Engineering Camp of the university on a tract of about 1,666 acres of land owned by the university and stretching from Douglas Lake to Burt Lake in Cheboygan County, Michigan, 17 miles south of the Straits of Mackinac. The instructors will include: Henry Allan Gleason, Ph.D., assistant professor of botany in the University of Michigan, acting director of the Biological Station; Frank Smith, A.M., associate professor of zoology in the Univer-

sity of Illinois, assistant professor of zoology; Max Mapes Ellis, Ph.D., instructor in biology in the University of Colorado, instructor in zoology; Harry Nichols Whitford, Ph.D., instructor in botany, and Paul Smith Welch, A.M., fellow in zoology in the University of Illinois, instructor in entomology.

The American Museum of Natural History, New York, has adopted a pension plan which went into effect on March 1. It is said to be the first instance in this country of a museum of sciences originating a pension system for the benefit of its employees. The idea was suggested to President Osborn after an investigation of the pension plans in operation in Europe. The plan is a contributory system, three per cent. of the annual salaries being paid to the fund by the employees and a like amount by the corporation. The plan provides: (1) Pensions—Six classes of pensions according to length of service and age, the pensions varying from twenty-five to fifty per cent. of the average salary of the last three years. (2) Health Insurance—Gratuity to the employee in case he is totally disabled through illness, or his position is abolished. (3) Life Insurance—Gratuity to a beneficiary, in the event of the death of the employee, and under certain conditions in the event of the death of a pensioner. (4) For the return of the employee's contribution with simple interest at three per cent. in case the employee leaves the service of the museum before he is eligible for a pension.

The U. S. Civil Service Commission announces an open competitive examination on May 12 for irrigation managers and assistants to fill vacancies in the position of irrigation manager at salaries ranging from $1,800 to $2,500 a year, and vacancies in the position of assistant manager at salaries ranging from $1,500 to $2,000 a year, in the Reclamation Service, the salaries being dependent upon the size of the project and individual qualifications.

A long summer trip is being planned for advanced geological students in Sheffield Scientific School of Yale University who are ready to complete their field work in geological surveying. For the past two summers, this work has been carried on in the region about Natural Bridge, Virginia; this year the field course, which will cover the six weeks from June 25 to August 6, will be carried on in the Spearfish Quadrangle, near Deadwood, South Dakota, in the heart of the Black Hills.

A cablegram to the New York *Times* states that the Atlantic transport steamship *Minneapolis* is carrying to America a consignment of about 600 British song birds for the great aviary in Michigan owned by Mr. Henry Ford, the automobile manufacturer. The aviary consists of about ten acres of land inclosed and covered with netting and is said to be the largest in the world. The consignment includes 120 larks, 120 linnets, 70 chaffinches, 100 greenfinches, 20 yellowhammers, 12 bullfinches, 40 blackirds and 12 jays.

UNIVERSITY AND EDUCATIONAL NEWS

The legislature of Kansas has appropriated $1,226,000 for the University of Kansas for the next biennium. The legislature refused all requests for new buildings except one for the medical school at Rosedale. The appropriation for maintenance is about $200,000 more than has been granted for any previous biennium for that purpose.

The total appropriations for special purposes of the Ohio State University carried by the appropriation measure now before the legislature, amount to $371,730. Two new buildings are provided for and half of the necessary cost appropriated, the balance to be appropriated next year. These buildings will be for the departments of zoology and botany, and the departments of horticulture and forestry. In addition to the special appropriations, the state levy will provide $400,000 for the general expenses of the university.

An endowment fund of $1,000,000 has been subscribed for Goucher College, Baltimore.

Harvard University has received from the estate of Mrs. Sarah A. Matchett, $150,000 on account of her bequest, to be held as a special

fund to be called the "Matchett Fund," the income of which is to be used for the general purposes of the college.

THE Catholic University, Washington, D. C., is to have three new buildings—two laboratories and a main dining-hall, which will seat 1,000. One building, the chemical laboratory, is to cost $300,000. The second laboratory building will house the departments of physics and mechanical engineering.

GOVERNOR SPRY, of Utah, has approved a bill recently passed by the legislature creating a department of metallurgical research in the state school of mines, the engineering school of the University of Utah. The new department will be in charge of a director who will be given from four to six young mining engineers and metallurgists as assistants. He will have no teaching whatever to do, but will devote his entire time to research work.

VERY radical changes are in progress in the chemical laboratory of the Rensselaer Polytechnic Institute. A new and larger lecture room is being built on top of the present one, and a new "water" laboratory, capable of accommodating sixty students, is under construction on the second floor. This additional laboratory will be very completely equipped for the analysis of water and sewage and every facility will be provided for undertaking such work from the chemical, bacteriological and microscopical standpoints. The quantitative and organic laboratories will be greatly extended, reequipped and furnished with conveniences of recent type, including glass shelving, enlarged hoods and individual arrangements for blast and suction on the desks.

THERE is pending in the Texas legislature a bill providing for the removal of the State Agricultural and Mechanical College from its present location near Bryan to Austin and its merging with the State University.

THE college of education of the Ohio State University will conduct the educational survey of Ohio, which was provided for by a recent act of the legislature. The purpose of this survey is to secure concise information concerning the condition of all educational interests of the state. Upon this information future legislation on educational matters will be based. Dean W. W. Boyd, of the college, will have personal supervision over the survey, which will be started at once.

THE Prussian ministry of education (Kultusministerium) has established a bureau of school information (Kgl. Preuss. Auskunftsstelle für Schulwesen) which was opened on April 1, 1913. Dr. Kullnick has been placed in charge of the bureau and will publish an annual year-book under the title of "Jahrbuch der Königlich Preussischen Auskunftsstelle für Schulwesen." The first issue will appear in November of this year and will include all manner of information concerning school matters, such as is not readily accessible in other official or non-official publications. Each volume will contain at least 320 pages. Persons who are desirous of securing information about German schools or school systems are referred to the new bureau, which will be ready at all times to answer any questions concerning these matters.

THE income of the Theresa Sessel fund given to Yale University for promoting original research in biological studies, will, for the present, be used in establishing two research fellowships, to be awarded on the recommendation of a standing committee composed of the chairman of the departments of physiology, zoology and botany, in consultation with the dean of the graduate school. In making the award, preference will be given to graduates of Yale or other universities, who have already obtained their doctorate and who have demonstrated by their work fitness to carry on successfully original research work of a high order. The fellowships will be of the value of $1,000.

FREDERICK SHELDON traveling fellowships for 1913–14 have been awarded in the sciences at Harvard University as follows:

Donald Clinton Barton, for research in geology in Europe and Egypt during the summer of 1913.

Sidney Fay Blake, for research in botany in Europe.

Elmer Keiser Bolton, for research in chemistry at Berlin.

Richard Maurice Elliott, for research in psychology, particularly in the psychophysics of handwriting, at Berlin and in the various psychological laboratories of Germany.

Harvey Cornelius Hayes, for travel in the United States, between September and February, for the purpose of observing the manufacture of alloys.

Sidney Isaac Kornhauser, for research in zoology at Würzburg and at the Naples Zoological Station.

Edward Hale Perry, for travel in the mining districts of the United States during the summer of 1913.

Joseph Slepian, for research in mathematics in Europe.

Paul Dudley White, for research in pharmacology at London and Strasburg.

Professor Ernest J. Berg, of the department of electrical engineering of the University of Illinois since 1909, has resigned that position to return to a similar position at his alma mater, Union University, at Schenectady, N. Y., and also to become consulting engineer of the General Electric Company of that city.

Professor R. W. Thatcher, director of the Washington Agricultural Experiment Station and head of the department of agriculture of Washington State College, has been elected professor of agricultural chemistry and soils in the University of Minnesota, the appointment becoming effective on May 1.

DISCUSSION AND CORRESPONDENCE

ELECTROMAGNETIC INDUCTION AND RELATIVITY

To the Editor of Science: In the last number of Science (March 14) Professor A. L. Kimball expresses the opinion that my recent experiments on electromagnetic induction are "not so definitely in contradiction to the principle of relativity as may appear at first sight," basing his conclusion on the fact that in certain cases the indication of a measuring instrument depends upon the manner in which it is connected to the apparatus under test.

This is a very important point, but it is naturally one which I had not failed to consider with great care. That no fallacy was made in reaching my conclusion will be evident, I think, from what follows.

Case I.—In my own recent experiments the cylindrical condenser, with its armatures A and B connected together by a wire C, remained at rest while the agent producing the magnetic field, whose direction was parallel to the common axis of the two cylinders, was rotated. The short-circuit by the wire C was then interrupted, *leaving the inner conductor B completely insulated. After the rotation was stopped and the field annulled,* B was tested for charge by connection to an electrometer. *No charge was detected.*

Case II.—Now imagine the condenser, together with its short-circuiting wire C, to rotate while the agent producing the magnetic field remains fixed to the earth. If the wire C is now interrupted, *leaving B completely insulated from A,* and if the condenser is then brought to rest and the field annulled, the cylinder B, *tested exactly as in Case I., will be found charged.* While the experiment in this form has not been made, the result given is an *immediate and necessary consequence* of the experiments by Faraday and others referred to in my earlier article. For no one will contend that in this case the seat of the motional electromotive force is elsewhere than in the wire C and in the dielectric, if any, entrained by the conductors in their motion. Moreover, that the ether is not entrained, and that the entrainement of any air would produce no appreciable effect, are facts which follow from some of the experiments (those on insulators) already referred to. In addition to these considerations only one assumption is necessary to the argument, viz., the assumption that an electric charge of one sign on an insulated conductor is not altered by being brought to rest from a state of motion.

Thus the condenser is actually charged in one case and not charged in the other, the relative motion in the two cases being exactly the same. If complete relativity existed, the condenser, tested in the way described, would be

found to have the same charge in the two cases.

In connection with Professor Kimball's remarks it is of interest to consider also the behavior of two electrometers E and E', one of them, E, fixed within the condenser with its terminals rigidly connected to the armatures A and B, and the other, E', fixed to the magnet, with terminals sliding on A and B. In Case II. E' indicates a voltage equal to the motional electromotive force in the wire C, and E gives no deflection—*not because the condenser is uncharged, but because the motional electromotive force in the electrometer and its leads just balances the voltage in the electric field produced between A and B by the motional electromotive force in the wire C.* In Case I. E again gives no deflection, *there being now no electric field between the armatures and no charge at all on the armatures;* and E' gives the same deflection as before—but whether for the same reason or not is still an open question. It is apparently because Professor Kimball was considering these ambiguous electrometer indications instead of the actual charges on the cylinders that he was led to his conclusion.

S. J. BARNETT

THE OHIO STATE UNIVERSITY,
March 18, 1913

A LABELING SURFACE FOR LABORATORY GLASSWARE

THE ground-glass circular spot now generally furnished on flasks and beakers made of Jena glass suggested to the writer the desirability of a similar labeling surface for microscopic slides, test tubes and other laboratory glassware. Attempts to use hydrofluoric acid showed that the acid in solution would dissolve the glass but would not etch it. "Diamond Ink" made by Merck and obtained from Eimer and Amend was found to give satisfactory results. "White Acid," obtained from the same firm, produces a less heavily frosted surface, but has been used to dilute the diamond ink when the latter has become unduly thickened. Diamond ink comes in gutta-percha bottles and etches glass immediately upon coming in contact with it. The hydrofluoric acid, which is apparently one of the constituents, is volatile. When a bottle has been opened, the fluid tends to creep out by capillarity along the salts that have been deposited by evaporation. The bottles, in consequence, should be kept sealed with paraffine when not in use.

In using, a small amount only of the creamy diamond ink is poured into a stender dish which has been previously coated with paraffine. A rubber stopper has been found to be the best means of applying the ink. One end is dipped into the ink and then pressed against the glass to be etched. If the right edge of the stopper is first touched to the glass and the pressure shifted from right to left and reversed, the fluid is evenly distributed and a small amount only is necessary for the even-edged circular spot which results. The etching takes place at once. The surface, however, is covered by a thick deposit of deliquescent salts which must be washed off before the ground-glass surface is ready to receive pencil marks. Ordinary glassware is easily marked by the method outlined, but the Jena glass tested is etched with more or less difficulty and has been ground on an emery wheel.

Adhesive paper labels are impracticable for test tubes or flasks that have to be sterilized with steam or that are kept in a moist atmosphere where they are liable to the attacks of moulds. Wax pencils, or better, indelible copying pencils moistened with alcohol are useful for temporary labels, but do not withstand steam sterilizing and are not permanent when much handled. Marking diamonds and certain silicate inks have the disadvantage of leaving a written label that can not be removed. A label written with lead pencil on an etched or ground-glass surface, however, has the advantage of permanency so far as ordinary laboratory handling is concerned. It is as permanent as pencil marks on paper and, like these, can be removed with a rubber eraser. The pencil marks are not affected by water nor by steam, but may be readily removed by scouring soaps. In cleaning test tubes, it has been found convenient to remove

the labels by rubbing the surface in a moistened groove in a cake of sapolio.

A. F. Blakeslee

Carnegie Station for
Experimental Evolution,
Cold Spring Harbor, N. Y.

MOST IS—WHAT?

To the Editor of Science: Since the natural sciences came into their inheritance, about thirty years ago, it has been quite the orthodox thing with the "humanists" to demonstrate the inherent disability of these subjects to impart "culture" by satirically deriding the English of embryonic doctorial dissertations. Judge, therefore, of the shock to my esthetic sensibilities occasioned by this sentence, which stands on page 61 in the issue of Science for January 10: "*most of the brotherhood of teachers of English is in the same state,*" where the adjective-noun most, having the plural form because clearly referring to number and not quantity, is made the subject of a verb in the singular number. This communication appears to have been written by a professor of English and, presumably, a humanist.

F. W. Martin

SCIENTIFIC BOOKS

Methods of Measuring Electrical Resistance. By Edwin F. Northrup, Ph.D. New York, McGraw-Hill Book Company. 1912. Pp. xiii + 389. Price $4.00.

The measurement of electrical resistance is of interest not only to the physicists but to engineers and others engaged in scientific, technical and commercial work. The methods used are described in various technical and scientific papers and in text-books on electrical measurements. But only a few of these are described in any one place, if we except Price's book written about twenty years ago. The author "has selected for presentation all those methods which in his judgment are useful, for commercial tests and measurements, for purposes of instruction in educational institutions and for application in technical and research laboratories." So we have collected in one book a large number of methods covering practically the entire field of electrical resistance measurements.

The first part of the book is of an introductory character and better than any other shows the wide experience and sound judgment of the author in matters pertaining to electrical measurements. Particularly good are his comments on accuracy and method and few there are, of those who make electrical measurements, who could not read with profit the first six pages. Then follows a discussion of errors and estimation of the accuracy obtainable by deflection methods. The way an error in measurement may affect the result desired is clearly shown, but no effort is made to arrive at the probable accuracy by the means of the theory of probabilities.

Deflection methods are taken up first. Various voltmeter methods and voltmeter and ammeter methods are considered very fully. Then follows a discussion of null methods and of these the differential galvanometer methods are considered first. In this connection no mention is made of the Kohlrausch method, which is generally considered to be by far the best and by some to be the only differential galvanometer method suitable for use in the precise comparison of resistances.

In the discussion of the Wheatstone bridge methods the Carey Foster method receives the fullest consideration. Six kinds of measurements are listed for which it is stated that this method "is especially useful." For one of these measurements deflection methods give all that is usually desired. When a higher accuracy is necessary it is easily obtained by the simplest kind of a bridge. Another is of interest only to the manufacturer in the adjustment of resistance coils. The other four can, provided a substitution method is used, be made much better with a simple bridge costing not more than half as much as the Carey Foster bridge.

In the discussion concerning Wheatstone bridges various arrangements of ratio and rheostat coils, including the author's four-coil decade, are considered; the author's special bridge for reading directly the per cent. error

in the adjustment of resistance coils is described; and valuable suggestions given in regard to the selection and use of bridges and auxiliary apparatus.

Methods and apparatus for measuring low resistances and calculation of conductivities are treated fully, as are also the methods and apparatus for measuring high resistance and the insulation resistance of cables. A chapter is devoted to the measurement of resistance-containing electromotive forces, insulation resistance with power on, resistances of batteries and electrolytes. Some of the methods described here were developed by the author.

A description is given of the author's dynamometer method for measuring the resistance of an inductive conductor to alternating current. A non-inductive resistance is adjusted so that the power dissipated in it is equal to the power dissipated in the inductive resistance as shown by the dynamometer. The two resistances being in series carry the same current and therefore have the same resistance.

The methods and apparatus used in locating faults are fully described. Here again some of the methods were developed by the author.

One of the important applications of electrical methods to other physical measurements is that of the measurement of temperature or temperature changes by means of the resistance thermometer. Apparatus intended for use between 0 and 100° C. should be capable of indicating small changes in temperature with certainty to .001° C. This means that changes in the resistance of the thermometer must be measured to better than 3½ parts per million of its total resistance. Therefore, careful attention must be given to the compensation for the various changes in resistance of leads, changes in resistance of contacts, etc. As the resistance thermometer must have a small heat capacity to follow temperature changes quickly and as it has a large temperature coefficient, the power supplied by the test current must be kept very small in comparison with that which might be used in the measurement of ordinary manganin coils of the same resistance. For this reason a sensitive galvanometer is required and care must be taken to correct for the thermo-electromotive forces, practically always large enough to introduce an error of a few thousandths of a degree. In discussing resistance thermometers the author apparently fails to appreciate the importance of some of these matters, for the arrangement which he is inclined to believe "offers more advantages than any other" if used in ordinary calorimetric work should hardly be expected to give satisfactory results. Much difficulty would be experienced in an accurate compensation for the changes in the resistance of the galvanometer windings. Then unless the galvanometer were more sensitive than the one which the author states "is amply sensitive for the purpose" we should hardly expect an accuracy better than that obtainable with a good mercury in glass thermometer. The galvanometer should be at least a hundred and preferably over a thousand times more sensitive.

Under the heading "Instruments Used for Measuring Resistances" the reader will find much in the nature of good advice both to the intending purchaser and user of such apparatus.

In the consideration of deflection instruments and galvanometers attention is called to what constitutes desirable qualities in anmeters, voltmeters, pointer galvanometers and mirror galvanometers. Instruments designed by the author and constructed under his supervision are described. The author's method of comparing galvanometers is given fully, together with a table giving constants of sixteen galvanometers. In this connection no reference is made to the important papers of White and Jaeger.

In an appendix a few mathematical formulas and tables, and physical constants are given.

Practically the entire field of resistance measurements is covered and most of the methods used are well described. However it is assumed that a .01 or even a .1 per cent. is a high accuracy and sufficient for all but very exceptional cases. The book will be welcomed by almost every one who uses resistance appa-

ratus and galvanometers—by the men engaged in commercial testing because of the description of the methods suited to the needs and the good advice given in regard to the selection of apparatus for different kinds of work; by the instructor in our educational institutions because it constitutes a valuable reference book for him and his students; by the specialist because to him the author succeeds in a marked degree in giving the benefit of his wide experience in the design, construction, and use of resistance and electrical measuring apparatus.

FRANK WENNER

BUREAU OF STANDARDS

Metabolic Water: Its Production and Rôle in Vital Phenomena. By S. M. BABCOCK. Research Bulletin No. 22, The University of Wisconsin Agricultural Experiment Station, March, 1912.

The purpose of the author in this paper of 181 pages is to show that metabolic water is not only produced in considerable quantity from the organic constituents of the foods and tissues of plants and animals by oxidation and hydration, but also that water from such sources exercises a different function from imbibed water, and that in very many cases is essential to the growth and continued life of the organism in question. The studies were conducted with corn plants for the most part. The studies from the zoological standpoint were not so extensive. The animals used were clothes moth (*Tinea pellionella*); bee moth (*Galleria mellonella*); pea weevil (*Bruchus quadri-maculatus*); flour beetle (*Tribolium confusum* and *Ephestia kuehniella*).

The scope of the study is indicated by the following selected headings taken from the table of contents: Sources of metabolic water (respiration, etc.); metabolic water in seeds; germination phenomena; metabolic water in mature plants; composition of plant tissues; development of hydrolytic ferments in seeds; imbibition; reserve nutrients in plants; water content of green and ripe fruits; intramolecular respiration; water produced in animal metabolism; water requirements of animals. The author seems to have shown in a rather convincing manner that metabolic water plays an immensely important rôle in the life of both plants and animals. The paper contains many facts collected together in a form such that they should be interesting to every plant physiologist.

RAYMOND J. POOL

THE UNIVERSITY OF NEBRASKA

Fresh Air and How to Use It. By THOMAS SPEES CARRINGTON, M.D. The National Association for the Study and Prevention of Tuberculosis. 1912.

This little book is timely and well conceived. It finds an enormous audience prepared to welcome it through sanitary precepts from press and platform for many years. Therefore the responsibility of the author is somewhat unique. One could wish that the execution of the work might deserve unqualified praise. Fortunately it should be easy for the author to correct such matters as call for adverse criticism.

We believe that it is better to be true than to be convincing Our author's introduction needs rewriting, for it is founded on the old conception that the prime danger from "bad air" lies in its chemical composition. His effort to put a known good thing on a scientific basis suggests the abominable method of instruction by which many popular school physiologies have been perverted for the purpose of lambasting narcotic drugs and alcohol.

In spite of a vast amount of research we are still none too well informed as to the essential physiological relations of "pure" air.

But it seems to have been demonstrated that all *morbid sensations* attributable to "foul air" depend wholly upon the effects of combined humidity and heat upon the skin. *Moving* air—a breeze—accelerates heat loss from the body, stimulates the skin in other ways and brings subjective comfort. Now in nature moving air is found most easily in the open or at least in apartments exposed to the open. Sanitary architects—God save the mark—find their task in evolving intricacies of construction whose design it is to obviate

the sanitary evils of construction. We have known of school rooms heated by the "indirect method" in which the winter air containing but a few grains of moisture to the cubic foot is warmed by passing over steam coils and then delivered to the school room, whose windows are closed by edict, its relative humidity so lowered that the moisture must be actually sucked from the skins and mucous membranes of the defenceless children. This air is chemically pure but physiologically like salt to a raw surface.

The little book under consideration is excellent in the orderly presentation of the various phases of the subject and too much praise can not be given for its profuseness of illustration, one hundred and fifty cuts being devoted to this purpose. The average mind derives a clearer idea of architectural design from a simple figure than from pages of labored description. It is to be hoped that in preparing another edition the author will carefully review his text with the purpose of removing all obscurity. Thus, the legend to Fig. 1, p. 22, reads "When the upper window sash is let down and the shade lowered, a larger amount of fresh air may be obtained by inserting a strip of open mesh netting between the shade and the roller." This is perfectly clear when the mechanism is understood, but it requires an undue mental effort to grasp its meaning. The author was happy in his section devoted to the use of clothing and he might profitably have discussed somewhat more in detail the physiological relations of textures—as, for example, the relative properties of silk, linen-mesh and woolen underwear. One of the most valuable chapters of the book is that which exploits the advantages of the house roof to the seeker after fresh air. It is worth enquiring whether it would not be well to devise a mirror situated so as to reflect the scenes of the street to relieve the monotony of "sitting out."

In the section devoted to the clothes-closet, it would have been well had the author insisted that garments, before being stored away, should be hung in the open air, in sunlight if possible, *with the pockets turned inside out.*

Few things are more difficult than to present a "nature study" which shall be scientifically true while forensically convincing to the lay mind. The practical essentials of fresh-air teaching have been excellently presented in this volume, but we are all too much interested in the subject to tolerate the smallest gnat in the ointment. Modern research suggests that the open air calls upon the autonomic systems of the body for somewhat the same kind of response that physical exercise demands of the skeletal nerves and muscles. We know definitely that in the treatment of tuberculosis, for example, exercise may be healing or deadly according to the state of the patient. The truth may very well be that a prescription of "fresh air" is not so simple, but must in scientific therapeutics be analyzed into its physical components of barometric pressure, motion, humidity, temperature, illumination and electric tension and to all these there must be added the one constant excipient—elixir of joy.

HENRY SEWALL

SCIENTIFIC JOURNALS AND ARTICLES

THE March number (volume 19, number 6) of the *Bulletin of the American Mathematical Society* contains the following papers: Report of the nineteenth annual meeting of the society, by F. N. Cole; "The product of two or more groups," by G. A. Miller; "The mathematics of Mahāvīrācārya," by D. E. Smith; "Shorter notices:" Townsend and Goodenough's First Course in Calculus and Essentials of Calculus, by N. J. Lennes; Dziobek's Differential- und Integral-Rechnung and Hack's Wahrscheinlichkeitsrechnung, by G. W. Myers; Brill's Relativitätsprinzip, Föppl's Technische Mechanik, Volume I., and Orlich's Theorie der Wechselströme, by E. B. Wilson; "Notes"; and "New Publications."

THE April number of the *Bulletin* contains: "Some general aspects of modern geometry," by E. J. Wilczynski; "On certain non-linear integral equations," by H. Galajikian; "A theorem on asymptotic series," by V. C. Poor; "On Poincaré's correction to Bruns' theo-

rem," by W. D. MacMillan; "Note on the groups for triple-systems," by L. D. Cummings; review of De Séguier's Théorie des Groupes de Substitutions, by G. A. Miller; review of Wilson's Advanced Calculus, by W. E. Byerly; review of Prasad's Differential and Integral Calculus, by E. B. Wilson; "Shorter notices"; Tannery's Mémoires scientifiques, Volume I., by D. E. Smith; Natorp's Logische Grundlagen der exakten Wissenschaften, Grelling-Enriques' Probleme der Wissenschaft, and Volkmann's Erkenntnistheoretische Grundzüge der Naturwissenschaften, by J. W. Young; Pascal's Repertorium der höheren Mathematik, second edition, by C. H. Sisam; Love's Differential and integral calculus, by Arnold Dresden; "Notes"; and "New Publications."

THE INFLUENCE OF VARIOUS EDUCATIONAL INSTITUTIONS UPON THE DEVELOPMENT OF AGRICULTURAL SCIENCE

EDUCATION in the general field of agricultural science is coming to occupy so large a place in primary, secondary and collegiate instruction, that the development of this field is of almost universal interest among educational workers. Both the subject matter and the pedagogical methods of agricultural science are so new as to be practically the creation of the present generation of research students and educators. It was of interest to the writer, therefore, to ascertain, as fairly as circumstances would permit, the sources for the inspiration and conception of the men who are building up this new science. It occurred to me to ascertain at what institutions of learning the men who were shaping the thought in this field secured their scholastic training, both undergraduate and postgraduate. Each of the leading educational institutions of the world is generally recognized as standing for a certain type of instruction or conception of educational methods. It seemed to be of interest to determine to what proportionate extent the ideals of each such institution are influencing the development of agricultural science.

For this purpose, a study was made of the number of degrees (exclusive of honorary degrees) granted by each institution to persons who are, or who have been during the past five years, members of the Society for the Promotion of Agricultural Science. This society does not, of course, include every person who is actively engaged in this field of work. But its membership does include a very large proportion of the leaders of this movement in America, and is probably closely representative of the scholastic training which such leadership has received.

DEGREES GRANTED BY VARIOUS INSTITUTIONS TO MEMBERS OF THE SOCIETY FOR PROMOTION OF AGRICULTURAL SCIENCE

	Bachelors	Masters	Doctors
Michigan Agricultural College	21	15	2
Cornell	9	9	7
Iowa State College	9	9	0
Harvard	4	4	5
University of Wisconsin	3	3	4
Mass. Agricultural College	9	1	0
University of Missouri	5	2	2
University of Michigan	4	2	3
Miss. Agricultural College	5	3	0
University of Illinois	4	2	1
University of Nebraska	4	3	0
Purdue	5	2	0
Yale	3	2	2
University of Maine	4	1	1
University of Ohio	4	0	1
Rutgers College	3	2	0
Johns Hopkins	1	0	3
Kansas Agricultural College	2	2	0
Colorado Agricultural College	2	2	0
So. Dakota Agricultural College	3	1	0
University of Washington	2	2	0
European universities	2	0	12

The proportionate distribution of the degrees received by these men among the several institutions does not necessarily indicate the relative esteem in which these institutions are now held by men of agricultural science as schools for training in this field. It is probably a more accurate measure of the opportunities which were available at the time when these men were seeking their scholastic training. Again, the present standards and ideals of these institutions may be quite different, with many of these men now on their facul-

ties, from those which prevailed in the institutions when they were undergraduate or graduate students. But it is believed that the figures given above approximately represent the influence of the several institutions upon the general trend of thought in agricultural science.

Of the 54 other degrees granted to members of this society, not more than three came from any one institution. In these computations no account has been taken of honorary degrees, only those granted for completion of prescribed work having been counted.

It is perhaps of interest to note that the 147 men who have been on the membership roll of this society during the past five years have received 128 bachelor's, 82 master's and 51 doctor's degrees earned by undergraduate and graduate study. While statistics as to the scholastic attainments of workers in other educational fields are not available for comparison, it appears to the writer that the scholastic training and ability of the men who are actively engaged in the promotion of agricultural science is certainly such as to command very high respect.

R. W. Thatcher
State College of Washington,
Pullman, Washington

SPECIAL ARTICLES

THE DISTRIBUTION OF OCCIDENTAL SPIDERS

A perfect knowledge of geographic distribution can not be had until we have good collections with good field notes from all important regions and a perfect taxonomy. That time is far distant. Meanwhile we can get some indications from the material at hand. One of the interesting problems concerning the relations between the two continents of the western hemisphere is the part, if any, which the West Indies has played in geographic distribution.

Spiders being carnivorous, and so probably not limited in their distribution by the distribution of special food, and being unable to fly or swim great distances, seem to offer excellent material for such a study. Unfortunately large collections have not been made and the taxonomy is rather chaotic. Omitting a number of genera either because of indefiniteness of information as to distribution or obvious errors in taxonomy, there still remain in Petrunkevitch's catalogue[1] 764 genera of spiders found in the western hemisphere. The distribution of these is analyzed to some extent in the table. While 119 of these genera are recorded as occurring in both South America and the United States, it is probable that there would be more were it not for the tendency to magnify taxonomic differences when political boundaries are crossed. It is somewhat surprising, in view of the usual notion that insular conditions lead to taxonomic separation, to find that only 14 per cent. of the West Indian genera are not found in neighboring regions, while 60 per cent. of the South American do not occur elsewhere. Even 22 per cent. of the Central American (Mexico being included) genera are not recorded as occurring in the adjacent regions.

Distribution of Genera of Spiders. Bold-faced type shows actual numbers; ordinary type, percentages.

	S. A.	C. A.	W. I.	U. S.
Total	**565**	**251**	**133**	**240**
Exclusive[2]	**338** 59.8	**54** 21.5	**18** 13.6	**90** 37.5
S. A., C. A.	**63** 11.2	**63** 25.1	**18** 13.6	**36** 15.0
S. A., W. I.	**27** 4.8	**18** 7.2	**27** 20.4	**7** 2.9
S. A., U. S.	**30** 5.3	**36** 14.3	**7** 5.3	**30** 12.5
C. A., W. I.	**18** 3.2	**6** 2.4	**6** 4.5	**8** 3.3
C. A., U. S.	**36** 6.4	**20** 8.0	**8** 6.0	**20** 8.3
W. I., U. S.	**7** 1.2	**8** 3.2	**3** 2.3	**3** 1.3
All four	**46** 8.1	**46** 18.3	**46** 34.6	**46** 19.2

[1] A. Petrunkevitch, "A Synonymic Index-catalogue of Spiders of North, Central and South America with all Adjacent Islands," *Bull. Amer. Museum Nat. History*, Vol. XXIX., 1911.

[2] In the sense that they are not recorded from any of the other regions considered here.

Of the 119 genera common to South America and the United States 39 per cent. are recorded also from both Central America and the West Indies, 30 per cent. also from Central America, 6 per cent. also from the West Indies and 25 per cent. from neither. It is probable that the latter percentage will be greatly reduced by further exploration of the intervening regions and by revisions of taxonomy by which either these genera will be split or species from intervening regions will be united with them. However, such distribution is not unusual in other groups and can not be discussed profitably more in detail with this material. The following extreme illustrations from the Linyphiidæ may be cited. *Gonatium* with one species in Patagonia, two in northern United States (one of them also in Europe) and one in Greenland; *Gongylidiellum* (closely related to *Gonatium*) with two species in Patagonia (one of them also in Argentina) and three species from Maryland to New York; and *Minyriolus* with one species in Patagonia and one in Massachusetts.

It was noted above that only 6 per cent. of the genera common to South America and the United States are found elsewhere in the West Indies, but not in Central America. Leaving out of the question the fact that these may eventually be found in Central America, it is evident that the West Indies have not been an important highway for the interchange of Arachnid fauna. We should expect the influence it has had to be most apparent in the fauna of our southeastern states, but only one out of 62 genera common to that region and South America is found in the West Indies and not recorded from Central America, while 35 per cent. of them are found in Central America and not recorded from the West Indies. This one genus is *Bolostromus* with one species (*B. fluviatilis*) recorded from Alabama, one (*B. insularis*) from St. Vincent and four from South America.

Therefore, making all allowances for deficiencies in taxonomy, records and my analysis of the records, we must conclude that practically the only interchange of spiders between the two continents has been by way of Central America.

Frank E. Lutz

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. SECTION D

Professor O. P. Hood, mechanical engineer for the Bureau of Mines, was elected vice-president of the association and chairman of Section D for the next meeting, at Atlanta. Professor A. H. Blanchard, of Columbia University, was elected secretary for five years to succeed G. W. Bissell, whose term expired. G. W. Bissell was elected a member of the council for the Atlanta meeting, and Mr. W. Bowie a member of the sectional committee for five years, *vice* A. H. Blanchard, whose term expired.

The section held meetings on January 2 and 3 for the presentation of papers. Vice-president J. A. Holmes, chairman of the section, presided on January 2, on which date the program was of a general character. Professor A. H. Blanchard presided on January 3 for two sessions devoted to papers on highway engineering. January 4 was assigned as a field or inspection day for those interested in good roads.

Retiring vice-president C. S. Howe, owing to absence on leave from Case School of Applied Science and other duties, did not present an address before the section.

The section is under obligations to the local committee and the authorities of Case School of Applied Science for the very excellent facilities for meetings; to those who, although not members of the association, contributed papers and discussions, and to those of its own membership who responded to requests for papers.

The secretary is indebted to Professor A. H. Blanchard for material assistance in the preparation of the program.

The Cleveland meeting of Section D was very encouraging to those interested, notwithstanding the storm on January 3 materially reduced the attendance.

Abstracts and titles are listed below by groups.

MISCELLANEOUS PAPERS AND TITLES

The Precise Level Net of the United States: Wm. Bowie, inspector of geodetic work, Coast and Geodetic Survey, Washington, D. C.

The Coast and Geodetic Survey has recently made an adjustment of the different loops or circuits or leveling forming the precise leveling net of the United States, which will give the most probable values for the elevations of bench marks. The datum used is mean sea level, and it is assumed that the mean levels of the Atlantic, Gulf of Mexico, and Pacific are in the same level surface. Deviations from this condition, if there are any, are not greater than the accumulated errors in a line of leveling joining any two of these bodies of water.

There are 44,720 kilometers (27,790 miles) of leveling, run in two directions, and about 10,700 permanent bench marks involved in the precise leveling. There is now precise leveling in all except seven states in the United States and the net is of such strength that the elevations resulting from the recent adjustment will probably be held as *standard* elevations for an indefinite time. This will be a great benefit to surveyors and engineers who experience great difficulties when the elevations of bench marks are changed or placed on different data. Theoretically, with each new loop added to the level net, new and better values for each bench mark may be obtained by an elaborate adjustment of the net, but the change from the old value would, in nearly all cases, be exceedingly small and insignificant, as far as engineering and surveying needs are concerned. The plan adopted by the Coast and Geodetic Survey is to hold fixed the old leveling and to fit any new sections to it. From time to time adjustments of the net will be made from which to obtain the theoretically best values of the junction points in the net, which will be of scientific interest only, and the resulting elevations would be needed for surveying and engineering purposes.

The Use of Logarithmic Coordinates in the Laboratory: D. MOOMAW, assistant professor, applied mechanics and hydraulics, Case School of Applied Science.

Presentation of diagrams, showing, on logarithmic cross-section paper, the method of determining the coefficients and exponents of curves of the second and third degrees, such as represent sometimes the relations between physical quantities in experimental work in the engineering or physics laboratory.

The observed values are plotted on logarithmic paper and the method applied simply and quickly.

The Michigan Industrial Compensation Act: G. W. BISSELL, dean of engineering, Michigan Agricultural College.

The most striking as well as the strongest feature of the law is that, except for farm and domestic help, the defenses of contributory negligence, negligence of fellow servant and assumption of inherent risks, are denied to the employer. The workingmen's compensation and employers' liability act has been in operation in this state about two and one half months, and so far the material provisions of the law and the machinery provided for its operation seem to be well adapted to carry out and make effective the general purposes of the statute. It is a well-constructed and workable act in its general features, and should be given a fair trial in its present form before any attempt is made to materially amend it. The general acceptance and approval of the law by a vast majority of the employers of labor in the state, and its approval by workingmen generally, constitute persuasive evidence that the act in its present form substantially meets the requirements and performs the functions intended.

California Electric Furnace Pig Iron: F. O. LANGENBERG, Athens, Ohio.

A brief account of electric furnace reduction in California and Sweden is given with a comparison of the practices in the two countries. A brief outline is given of the California furnace: (1) description of the furnace and electrical equipment, (2) operation and product of the furnace.

Part Two deals with a microscopic study of pig irons. Two samples of California iron are discussed and their chemical and physical properties predicted by the aid of the microscope. These predictions are confirmed by analyses. The influence of the rate of cooling on the size of the graphic flakes is also shown.

Present Status of the Gas Turbine Problem: F. C. WAGNER, professor of mechanical engineering, Rose Polytechnic Institute.

It seems probable that with the gas turbine, as in the case of the steam turbine, the most profitable field will be in large units, when large volumes can be handled with a relatively small machine. In large installations, also, it would be worth while to install apparatus for saving the heat in the exhaust gases.

Altogether the gas turbine art has made substantial progress during the past year and the outlook for practical development in the near future seems especially favorable.

Notes on Some Properties of Explosive Mixtures of Air and Gas: F. H. VOSE, professor of mechanical engineering, Case School of Applied Science.

The paper refers particularly to some experiments performed with explosive mixtures of air and illuminating gas. These experiments were conducted at Washington University, St. Louis, Mo., the gas used being the illuminating gas from the city mains.

The investigation was undertaken to determine the effect of the presence of water vapor on the properties of explosive mixtures, such as pressure ratio resulting from combustion as well as the time increment involved for the completion of combustion.

While the investigation covered a wide range of mixtures, the paper was written to cover a mixture containing 4.75 parts of air to 1 part of gas by volume. This mixture approximates the theoretically best mixture for complete combustion.

Pressure rise was measured by means of the ordinary gas-engine indicator and time records obtained from tuning-fork records on the indicator card. The indicator drum was driven at a constant rate.

Slides made from original cards are shown to indicate the character of the results. Curves were also presented giving the results in graphic form.

When water vapor is present in the ratio of 0.05 parts by weight to the gas mixture a pressure ratio from explosion $= 5.5$ results; when the quantity of water vapor present represents 0.35 parts by weight the pressure ratio resulting from explosion is only 2.3. The retarding effect on flame propagation is correspondingly great.

The Manufacturing Organization: HUGO DIEMER, State College, Pa.

Organization defined, Organization distinct from system and management, To lay out a new organization or to analyze an existing one, Numerical military type, Specialized type, Functionalized type, Staff principle applied to industry, Selecting the type or organization and control to be applied to a given industry, Determining the will of the organization as a whole, Setting forth specific duties, A typical conventional industrial organization, Department of records, Department of materials, Department of plant, equipment and processes, Routing, Scheduling, Motion and time studies, Preparing instruction, instruction cards and instruction sheets, Standardization of equipment, Department of men, Hygiene and efficiency, Psychology and efficiency, Industrial education, Development of loyalty through social and religious activities, Line organization, Progress of an order through an industrial establishment, Carrying into effect the above principles.

A Further Analysis of the Deflections and Stresses in Reinforced Concrete Floor Slabs Constructed on the Turner Mushroom System: H. T. EDDY, dean of the graduate school, University of Minnesota.

At the Washington meeting last year the present writer gave an account of his success in developing a rational analysis of this kind of flat slabs. That analysis was based upon the application of the theory of circular plates to this form of construction.

In making such application, it is implicitly assumed that any one of the panels of a slab is supported by surrounding columns in such a symmetrical manner that the central part of a panel carries its loading approximately in the same manner as a circular plate would do when suitably supported at its circumfernce. This supposition will be nearly exact at points near the center of the panel and less so the greater the distance from the center.

Again the part of the slab at and near a column head in a slab of many continuous panels will have the loading and supports so symmetrically disposed about it that it will act nearly like a circular plate with a central support at the column, at least for points near the column.

While the application of these principles was found to give sufficiently precise values of the central deflections of panels, and of the stresses at the same points, and over the columns, at other points than these the results were not and could not be expected to reproduce the results of tests. It therefore appeared desirable to develop a more closely approximate general theory of the flexure of the reinforced concrete flat slab.

The writer has had unexpected success in developing this general theory from the fundamental differential equation of flexure of slabs, by the help of which its deflections at any points are readily computed, as well as the stresses in reinforcing rods and concrete, notwithstanding the extreme irregularity of distribution of the reinforcement. This last fact requires certain hypotheses in the adaptation of the general solution for a uniform slab to the actual slab, which are proved to be admissible approximations by the agreement of actual tests with numerical computations.

Many interesting and unexpected results appear as part of this investigation whose main conclusions have been already reached. Among these is the fact that the point of maximum stress in steel is midway directly between columns and not at the center of the panel.

It is the intention of the writer to prepare and publish a treatise upon this subject after concluding his investigations upon flat slabs and upon the theory of combined beam and slab floors. These forms of construction have been ordinarily treated by American engineers by applying some form of beam theory to their computations. This has been a fruitful source of bad design and error, because in beam theory the moment of the applied forces is equal to that of the resistance of the beam, whereas in slab theory such an equality does not exist, since these may differ by 100 per cent.

It has been found that slabs are in fact perfectly safe which beam theory would regard as far otherwise. Correct theory is therefore of extreme importance in slab design.

The Significance of Empirical Tests to the Application of Explosives in Practise: CLARENCE HALL, U. S. Bureau of Mines, Pittsburgh.

Read by title.

Sampling Coal Deliveries: G. S. POPE, Washington, D. C.

Read by title.

Smoke Prevention in Cleveland: E. P. ROBERTS, city smoke inspector, Cleveland, Ohio.

A brief account of the routine of city department of smoke inspection and results accomplished at prominent plants, with locomotives and steamships.

When possible plans for boiler settings are reviewed before installation to prevent unnecessary expense to the owner.

Cleveland has noticeably improved in the matter of smoke during the past few years.

Mr. Roberts also exhibited a novel and valuable smoke chart intended to overcome the objections to the Ringelman charts.

PAPERS ON HIGHWAY ENGINEERING

Bond Issues for the Construction of State Highways: JAS. R. MARKER, state highway commissioner, Columbus, Ohio.

Read by title.

The Design of Various Types of Highway Bridges from the Standpoint of Modern Traffic: FRANK H. NEFF, professor of civil engineering, Case School of Applied Science, Cleveland, Ohio.

Subject discussed at length by the author and liberally illustrated with lantern slides.

Methods of Repairing Cement Concrete Pavements: FRANK F. ROGERS, deputy commissioner, State Highway Department, Lansing, Mich.

In practise repairs to these pavements are made by two distinct methods, depending on whether the defects are on the surface or extend deeper into the mass. Surface treatment is given by first cleaning the defective places, then filling, or covering them with hot bitumen, preferably refined tar, and coating with sand. This applies to wear at the expansion joints and to cracks caused by natural causes as well as to a pitted condition of the surface, and tends to prevent further deterioration of the places repaired. As a rule, repairs of this kind have to be made annually. In Wayne County, Michigan, the cost of such repairs has been about $50 a mile. When the defects lie deeper a portion of the concrete is chiseled out, usually to the sub grade, the exposed edges thoroughly cleaned and given a wash coat of neat cement, after which the excavation is filled with the same kind of concrete that was used in the original construction. Repairs of this kind generally prove satisfactory. Bellefontaine, Ohio, reports that repairs on 4,400 square yards of cement concrete pavement laid in 1893 and 1894 have cost only about $200.

Relative Advantages of Laying Brick Pavements on Sand Foundations and Cement-Concrete Foundations: ROBERT HOFFMAN, chief engineer, Department of Public Service, Cleveland, Ohio.

Relative economy of using a sand or concrete foundation for a brick pavement depends upon its first cost, cost of maintenance and life. Accurate data relative to maintenance and effect of traffic is not at hand. Records of cities which show the time that has elapsed between the laying and relaying of a pavement affords the best available evidence upon which to base estimates of relative economy.

In Cleveland, which is chosen as a representative city with reference to brick paving, prices paid per square yard of brick pavement, have varied as follows:

5 in. brick laid on natural sand foundation, $1.18 to $1.56.

5 in. brick on 8 in. sand or gravel ballast foundation, $1.40 to $1.97.

5 in. brick on 6 in. concrete foundation, $1.94 to $2.48.

4 in. brick on 6 in. concrete foundation, \$1.71 to \$2.34.

4 in. brick on 4 in. concrete foundation, \$1.47 to \$1.73.

During the last three years the following average price has been paid.

5 in. brick laid on natural sand foundation, \$1.27 per sq. yd.

5 in. brick on 8 in. sand or gravel foundation, \$1.58 per sq. yd.

4 in. brick laid on 4 in. concrete foundation, \$1.60 per sq. yd.

Average life of five inch brick on sand foundation is taken from the city's experience to be fifteen years. Four-inch brick on sand foundation is assumed as twelve years. From this data it is calculated that four-inch brick can be laid on four-inch concrete as economically as the five-inch on natural sand foundation if the life will be twenty-two years. Four-inch brick can be laid on six-inch concrete as economically as five-inch brick on eight inches of sand or gravel foundation if its life is eighteen years.

It is concluded that when conditions are favorable a five-inch brick laid upon a good natural sand foundation will form the cheapest form of brick pavement, but in all other cases one with a concrete foundation will prove the most economical.

Some Considerations Affecting the Interaction of Motor-vehicle Wheels and Road Surfaces: DR. L. I. HEWES, chief, division of economics and maintenance, Office of Public Roads, U. S. Department of Agriculture, Washington, D. C.

In this paper, the author suggests the fundamental work equation

$$(1) \qquad \frac{h}{v} = f,$$

where h is effective horsepower developed at the tires of the motor wheels of an automobile, v is the velocity, and f the total resistance. This equation obtains on a level at constant speed and with the air resistance neutralized by a wind current parallel to the velocity of the machine. It is important to determine the nature of the resistance f, which is in a sense a road coefficient, as it must vary for the same automobile on different roads. The resistance to the motion above described can not be solely due to the action of gravity on the weight of the machine as much as assumption demands a constant resistance for all speeds on the same road. A table is presented showing the relation between effective horsepower, velocity and resistance of traction. This table was published in *Le Genie Civil*, Vol. LXI., No. 14, p. 276, and exhibits the relation of equation (1). It is the record of tests made in 1912 in Paris on a Berliet truck.

The author discusses two sources of resistance which must be included in the symbol f. First the resistance which is developed by the motion of the points on the automobile tire not in contact with the ground and which strike small particles with a *positive forward velocity*. It is pointed out that a point on the periphery of a tire moves in a cycloid and at the instant of contact has zero velocity, whereas points immediately adjacent to the periphery and not in contact with the ground move in rolling curves with velocities having considerable horizontal components which may produce small and continuous shocks, which, owing to the varying magnitude of the velocities in the same vertical cross-section, can produce twisting action upon small particles comparable to the "English" of a billiard ball and thus throw small material to one side of the path. Table of velocities of points at varying vertical distances from the road surface follows. A second source of resistance is described. This resistance is due to the fact that the pneumatic tire which is in the form of a torus is not applicable to road surfaces without deformation. The increment of tensions in the tire material due to such deformation is described and it is pointed out that such rubbing action on the road surface, while simultaneous, is continuous and the sum of such effects must cause a portion of the resistance f. The author concludes that on account of both sources of resistance it is desirable to preserve the enamel of the road surface intact and free from all loose particles, and further that the interaction of road and tire must continue unfavorable both to road and tire, unless the section of the tire is made trapezoidal.

Bituminous Surfaces on Brick Pavements: ELLIS R. DUTTON, assistant city engineer, Minneapolis, Minn.

The use of a bituminous coating on the surface of old and new brick paving is desirable and beneficial. It gives a more pleasing appearance to the street, reduces the noise, affords better foothold for horses—and lessens the wear of the brick.

A bitumen which would be satisfactory for this purpose should be of a very adhesive quality all the time, under all conditions of moisture and temperature, and should not become excessively

soft in hot weather—nor become brittle in cold weather.

It should be composed of such materials that would be and remain stable under all conditions and not evaporate or lose its most valuable properties.

It should be applied in the best and most approved manner, so as to produce the best results capable for the quality of the bitumen. The surface of the brick should be made perfectly clean, free from dust and moisture. The bitumen should be applied at the proper temperature—in a proper manner and under favorable weather conditions.

After application of the bitumen the surface should be covered with either fine granite or trap chips, torpedo sand or a coarse sand.

Such a bituminous coating would make the ideal brick pavement.

Small Stone Block Pavements: A. H. BLANCHARD, professor of highway engineering, Columbia University, New York City.

Illustrated with lantern slides of European and American pavements of this type.

The Organization of Town Highway Departments: FRED BUCK, assistant deputy commissioner, New York State Highway Department, Albany, N. Y.

There are three essential points to be observed in formulating any plan for the improvement of the highways of any commonwealth.

(*a*) A series of improved thoroughfares connecting the principal centers of population.

(*b*) A series of improvements to the highways which form the principal tributaries to those first mentioned.

(*c*) All highways in the commonwealth not included in the first two classes.

No plan for financing a scheme of highway improvement has yet been advanced which will make possible the improvement of a total of more than 12 per cent. of the mileage of any state, of the character indicated for classes (*a*) and (*b*) within the next 15 or 20 years; and any plan which contemplates the improvement of 12 per cent. of the mileage of any commonwealth without giving attention of some kind to the remaining 88 per cent., fails in large measure of attaining its full value to the commonwealth as a whole.

Roads comprising class (*c*), in this article, are, in the state of New York, under the jurisdiction of the Bureau of Town Highways, and since the organization of that bureau, very gratifying results have been accomplished.

With no greater town taxes than were raised under the old "Labor System," about 3,600 miles of good town macadam roads have been built, about 8,400 miles of good gravel roads, and about 50,000 miles have been properly shaped and crowned and standardized as to width.

By furnishing plans and encouraging town superintendents to construct culverts and short-span bridges with their own local labor, utilizing local materials wherever possible, in 1911 there was effected a saving, in actual cash, to the taxpayers of the state more than three hundred and fifty thousand dollars, not taking into any account the vastly superior strength and durability of the structures so erected.

The results of the plan in New York seem to clearly prove that a thoroughly organized, well equipped town highway department is one of the essential parts of any general scheme of highway improvement.

Brick Pavements for County Highways: W. C. PERKINS, Niagara Falls, N. Y.

Presented by the author, and illustrated by lantern slides.

A City Traffic Census: W. H. MESSENGER, S.B., assistant engineer, Bureau of Highways, Brooklyn, N. Y.

The above bureau inaugurated a permanent census of its vehicular traffic in June, 1912. The forms used divide traffic into two large classes, rubber-tired and iron-tired, with appropriate subdivisions of each class. Starting with a small squad of six men, working eight hours a day, rain or shine, observations have been made at some 400 points mostly in duplicate. Duplicate observations are separated by a period of 15 days. A few night and Sunday records have been taken.

Results are tabulated to give the density and tonnage. The density is computed for number per foot of roadway per minute, per line of traffic per minute, and on the basis of traffic units as used by the London Traffic Branch. Tonnages are founded on extensive inquiry among those best knowing weights of different vehicles of business and recreation, and are assembled to give daily, weekly and annual amounts per foot of width of roadway, to the end that durability or total life may eventually be found for all classes of pavement.

The results thus far obtained have been used by the city planning committee, and are daily called for in connection with the determination of the class of pavements to be laid on certain streets in the immediate future.

This census was inaugurated by Mr. H. H. Schmidt, chief engineer, and placed under the charge of the writer.

Petrographic Study of Rocks for Road-making in the Office of Public Roads: E. C. E. LORD, petrographer, U. S. Office of Public Roads, Washington, D. C.

This paper contains a review of a quantitative, microscopic method of rock analysis by means of a cross-line field, and a brief statement of the principal road-making rocks, their method of classification and physical properties. Attention has been called to the effect of mineral composition and rock structure on the wearing properties of road materials.

It has been shown that the dense, fine-grained, igneous rocks (traps) are generally more tough and offer greater resistance to wear than the coarser grained igneous, or the more loosely textured sedimentary and metamorphic rocks. In consequence of their superior toughness, the screenings from trap rocks are found to be sharper and more wedge-shaped than those from other rock types and therefore produce a more permanent bond when compacted with the larger road stones.

This interlocking of the coarser portion of the screenings with the rock fragments forming the wearing course of the road constitutes the mechanical bond of the road surface, and should be distinguished from the cementing bond of the fine dust which is due to the presence of adhesive mineral substances of a more or less colloidal character. This cementing value has been found insufficient in many cases to withstand the effect of modern traffic and it has therefore been suggested to make use of the highly cementatious basic open hearth slag dust to overcome this difficulty.

Field Methods for Laying Out Highway Curves: HENRY B. DROWNE, instructor in highway engineering, Columbia University.

Read by title.

The Value of Microscopic Analysis of Rocks to be Used in the Construction of Roads and Pavements: J. F. KEMP, professor of geology, Columbia University.

Read by title.

Municipal Plants for the Storage of Road Oil: WILLIAM H. KERSHAW, chief engineer, Paving and Roads Division, The Texas Company, New York City.

After comment on the existing conditions regarding the lack of equipment for storing road oil, with its resulting economic loss, detailed statements of the cost of tankcar equipment is given, showing that all extra expense in the handling of road oil that results from lack of proper storage facilities eventually becomes a part of the cost of the oil. Figures given show that 12,000 gallon tanks can be erected at an approximate completed cost of $700. A statement is made that the saving of the accumulating demurrage now charged by the railroads will pay for the erection of the tank and the saving in the cost of the oil will show an earning on the investment.

After describing existing municipal storage plants, a simple form of single compartment tank is suggested that will hold 12,000 gallons and is fitted with steam coils and on which all outside piping is steam jacketed, which will cost complete approximately $700 and is capable of handling all of the heavier grades of binding oils and solid bitumens as well as the lighter grades of road oil.

The Consistency of Bituminous Materials, its Determination and Value in Specifications: MAJOR W. W. CROSBY, chief engineer to the Maryland Geological and Economic Survey, and consulting engineer, Baltimore, Md.

The consistency of a bituminous material is defined as its degree of firmness and determined by internal friction.

The determination of consistency is now usually made by one or more of half a dozen instruments designed on three general principles.

The instruments described, however, do not now cover in their range the entire field of materials and some materials are difficult of measurement in the matter of consistency by any of the older and more customary instruments.

The desirability of a single instrument for the purpose, whose range will cover readily the entire field of materials, is evident. Two such, newly proposed and as yet not generally used, are described. A modification in the customary methods of performing certain tests is advocated.

The value of a proper determination of consistency is shown by the dependence, on this characteristic, of the methods of using a material, by the information which such a determination gives concerning the probable results of such use, and concerning the value of the material itself.

Specifications containing definite descriptions of

the consistency of a pitch and drawn in physical terms are particularly appropriate for physical work such as road-building, and such specifications are more likely to be readily understood than where chemical expressions are used, perhaps to cover the same points in a less direct way.

The writer believes that valuable research work can be done by investigations into the consistency of bituminous materials or pitch compounds, and that from such work the art of road-building will be advanced.

The Value of Specifications and Tests for Bituminous Materials: CHARLES S. REEVE, chemist, U. S. Office of Public Roads, Washington, D. C.

The author urges the importance of purchasing bituminous materials upon a specification. The maker of such a specification, however, should know the relations to one another of the particular characteristics he demands, and the ability of the producer to meet his requirements. Advance samples and shipments should be tested to insure the acceptance of satisfactory material and to furnish records of tests which may prove of value later. Examples of recent neglect to fulfil certain specifications are given, and in some cases this neglect would have proved serious but for the fact that careful inspection averted the use of the undesirable materials. The practise of purchasing upon a trade name only is criticized, and an example is cited which shows a recent failure due to this practise. The author concludes by urging the highway engineer to protect himself by the careful purchase and inspection of materials.

The Evaporation of Bituminous Materials, its Determination and Value in Specifications: PREVOST HUBBARD, in charge Division of Roads and Pavements, The Institute of Industrial Research, Washington, D. C.

Read by title.

Fixed Carbon in Bituminous Materials, its Determination and Value in Specifications: LESTER KIRSCHBRAUN, director, Chicago Paving Laboratory, Chicago, Ill.

The writer describes the standard method of determining fixed carbon in bitumens, and points out some of the factors of manipulation necessary of observance in order to obtain correct and consistent results. A discussion of the derivation of fixed carbon produced upon ignition of bitumens is given, and its significance applied in three particulars. First, as a means of identification of certain native bitumens; secondly, as a means of checking the suitability of combinations of flux solvents with hard, highly condensed bitumens; and again, as applied to oil asphalts, as an index of the severity of heat treatment to which such materials have been subjected in the course of their production. This latter feature is demonstrated by graphical data showing the effect upon the fixed carbon yield in runs of oil asphalt made from the same crude at different temperatures. The effect of the character of the crude from which these products are made as influencing the fixed carbon characteristics, and the application of this test to specifications, is pointed out.

A Method for Determining the Toughness of Bituminous Materials: J. E. MYERS, chief chemist New York State Highway Department, Albany, N. Y.

The toughness of bituminous materials is determined by filling a 3 oz. tin box (3.5 cm. deep by 5.5 cm. in diameter) with the melted material. The material is allowed to cool to room temperature. When cold the box is held by a pair of tongs, rapidly heated over a Bunsen burner, and the material emptied into a can of cold water. In heating, only enough heat is applied to free the material from the box, so when emptied into the water the material is still solid, being softened only on its exterior. By wetting the hands this cylindrical shaped piece of bitumen is easily rolled into a ball which will be free from seams.

The ball is maintained at the temperature at which the test is to be made (usually at zero degrees C.) for at least one hour before testing. The balls are tested in the impact machine adopted by the American Society for Testing Materials, for determining the toughness of rock used in macadam roads. The essential working parts of the impact machine are the anvil, of 50 kilograms weight; the hammer, of 2 kilograms weight, and the plunger, of 1 kilogram weight, the plunger having a hemispherical-shaped head of 1 cm. radius.

In testing asphaltic materials the drop of the hammer is taken from a height of 5 cm. for the first blow and the drop of each succeeding blow is increased 5 cm. The height from which the hammer falls when rupture occurs is given as the toughness of the material.

Distillation of Tar. Methods of Determination, and Value in Specifications: PHILIP P. SHARPLES, chief chemist, Barrett Manufacturing Co., Boston, Mass.

The methods in use and proposed for the distillation of tars and refined tars in road work are so varied and give such varied results that there is urgent call for their standardization. Attention is called to the excellent work of the Subcommittee on Distillation of Committee D—4 of the American Society for Testing Materials and their recommendations.[1]

The distillation test in a specification should be so drawn as to show, in conjunction with the free carbon, specific gravity and viscosity: (1) absence of water; (2) character of tars used; (3) method of refining. It is important that in addition to the amount of distillate, its specific gravity and the melting point of the residue be required.

Classification of Rocks Used in the Construction of Roads and Pavements: CHARLES P. BERKEY, assistant professor of geology, Columbia University.

Read by title.

Specifications for Patented Pavements: WILLIAM H. CONNELL, chief, Bureau of Highways and Street Cleaning, Philadelphia.

Read by the secretary.

The History of the Topeka Bituminous Concrete Pavement: THEO. S. DELAY, city engineer, Creston, Iowa.

In the early days of the use of bituminous paving surfaces various arrangements of aggregate and various bituminous materials were used, the materials and methods being adapted to the work contemplated.

About the year 1893 Marcus A. Hodgman, a paving superintendent, in the employ of F. O. Blake, in Denver, reverted to some of the earlier practises in laying bituminous pavements.

Hodgman's work was seen by Frederick J. Warren, an employee of the Barber Asphalt Paving Company, who subsequently resigned from the employ of that company, went east, and took out a patent on a similar form of construction.

Warren organized the Warren Brothers Company to promote the invention and by vigorous promotion methods succeeded in having built a very considerable yardage of paving in accordance with this method.

Hodgman died in 1903, but Blake continued in the paving business and evidently still had a good opinion of Hodgman's idea, as he promoted some pavement in accordance with that principle in Topeka, Kansas, about the year 1908.

Before this work was constructed, Warren Brothers Company brought suit for infringement of patent against the city of Topeka and the contractor. The defendants called on Blake for assistance to such good purpose that, when the case came up for trial, the plaintiff was willing to enter an agreed decree waiving claim of infringement but enjoining plaintiff against infringing.

Early in 1910 the city of Creston, Iowa, started proceedings for the construction of 25,000 yards of bituminous concrete paving and adopted the specifications used at Topeka. Creston also was made defendant in a suit by Warren Brothers Company, and this was settled by an agreed decree as in the Topeka case, but without any injunction clause.

Since it has become known that this form of pavement is free of difficulties it has been used very extensively in the middle west, with general satisfaction. It is not, however, a new form of construction, as it has been in continuous use in Pittsburgh, Pa., since 1897.

Its use has been instrumental in greatly reducing the cost of paving to the taxpayer, as may be seen by comparing prices at Creston with those of other places.

As this form of construction yields no exorbitant profits it has no promoters, hence has not met with acceptance as rapidly as its merits deserve.

It is subject to one objection common to all continuous pavements, namely, cracking under sudden changes of temperature. These cracks do no harm, show no inclination to ravel, and close up during warm weather when sufficient traffic passes to keep the pavement worked.

Economical Methods of Repairing Sheet Asphalt Pavements: H. B. PULLAR, assistant manager and chief chemist, The American Asphaltum and Rubber Co., Chicago.

Read by title.

Limitations in the Use of Bituminous Carpet Surfaces: ARTHUR W. DEAN, chief engineer, Massachusetts Highway Commission, Boston.

Read by title.

The Maintenance of Bituminous Pavements: JAS. C. TRAVILLA, street commissioner, St. Louis.

Read by title.

Observations on Slipperiness of Bituminous Surfaces and Bituminous Pavements: W. D. UHLER,

[1] *Proceedings of the American Society for Testing Materials*, Vol. XI., 1911.

assistant chief, Bureau of Highways and Street Cleaning, Philadelphia.

Read by title.

The Mixing Plants Used in the Construction of the Topeka Bituminous Concrete Pavements of the Borough of Queens in 1912: A. F. Gruenthal, assistant engineer, Bureau of Highways, Borough of Queens, N. Y.

Read by title.

Bituminous Gravel Concrete Pavements: Spencer J. Stewart, division engineer, New York State Department of Highways, White Plains, N. Y.

This pavement consists of mixing Hudson River cementatious gravel, heated to a temperature of over 225 degrees F., with natural lake asphalt heated to a temperature of not less than 275 degrees F., then placing both ingredients in a mechanical revolving mixer and thoroughly agitating until all the particles of the mineral aggregate are thoroughly and completely coated with the bituminous material.

This mixture, at not less than 250 degrees F., is then spread upon the prepared bottom or foundation course.

The gravel is composed of calcareous sandstone, granite and quartzite, associated with a considerable amount of finer particles of the abovenamed rocks, together with a percentage of clay. This latter substance gives the gravel a good cementatious value, which is an essential to the comparative permanency of the pavement. The clay acts as a catalyzer on the asphalt, making it more viscous, less volatile and also less brittle.

The advantages of this pavement are:

First, its comparatively low cost over so-called semi-permanent pavements.

Second, on account of its adaptability to country and parkway purposes, due to its easy riding surface and its conformity to our ideals of the surroundings of a parkway or country highway.

Third, on account of its non-slippery nature, it being practically a "non-skid" road.

From the contractor's bids, the average cost of this pavement is about $0.85 per square yard.

A Review of the Use of Bituminous Materials in the Construction and Maintenance of American Highways during 1912: Arthur H. Blanchard, professor of highway engineering, Columbia University, New York City.

G. W. Bissell,
Secretary

East Lansing, Mich.,
March 10, 1913

SOCIETIES AND ACADEMIES

THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

The fifteenth regular meeting of the society was held at the residence of Dr. Ransom, March 20, 1913, Dr. Ransom acting as host and Mr. Chambers as chairman.

The comparative anatomy of the free-living and the parasitic nematodes was discussed by the society.

Mr. Crawley presented a note reviewing Muriel Robertson's work on *Trypanosoma gambiense* and its vector, *Glossina palpalis*. She has shown there is a rhythmic cycle in the life of the trypanosome in the vertebrate host, the parasite falling off in numbers at times until there are only a few small forms present, which then begin to multiply with a resultant production of larger forms until the blood contains numerous large forms, and the cycle repeats. An endeavor to correlate this alternation of few small forms and numerous large forms with the infectivity of the trypanosomes for its invertebrate host, the tsetse fly, developed the fact that the infectivity was at its maximum when the few small trypanosomes were in the blood and at its minimum when the many large forms were present.

Dr. Ransom presented a note on "The Reported Hosts of *Cysticercus cellulosæ.*" It is commonly stated in general works on parasitology that *Cysticercus cellulosæ* occurs not only in the pig, its usual host, and in man, a not uncommon host as a result of auto-infection, but also in the dog, cat, bear, sheep, deer, rat and monkeys. It has also been reported from a seal.

The only hosts, however, in which the occurrence of *Cysticercus cellulosæ* can be considered to have been proved are the first three named. The reputed occurrence of *C. cellulosæ* in the cat, bear, rat and seal rests apparently upon a single instance of the discovery of cysticerci resembling *C. cellulosæ* in these hosts without proof by feeding experiments. Likewise, though several cases of *C. cellulosæ* have been reported from monkeys and rather many cases from sheep and deer, no experimental proof or other evidence of a conclusive nature that the parasites in question were really *C. cellulosæ* has been furnished. On the contrary, the evidence thus far available tends to prove the non-occurrence of *C. cellulosæ* in these animals, particularly in the case of sheep and deer. It has, in fact, been recently shown (Ransom, 1913) that the muscle cysticercus of sheep

resembling *C. cellulosæ* is the intermediate stage of a dog tapeworm; consequently very definite and detailed evidence must be produced before any case of cysticercus in sheep can be accepted as a case of *C. cellulosæ*. Similarly, more definite evidence than has been furnished in the various reported cases of muscle cysticerci in deer will be required before any such can be accepted as a case of *C. cellulosæ*. Though it is perhaps not surprising that the muscle cysticerci of sheep should have been accepted as *C. cellulosæ* in view of the fact that sheep commonly live in rather close relationship with human beings, it does seem, on the other hand, surprising that the reports of cases of *C. cellulosæ* in deer should not have been questioned heretofore. Furthermore, it would seem, in view of the fact that it has long since been shown (Moniez, 1879) that the cysticerci in reindeer somewhat resembling *C. cellulosæ* are the larvæ of a dog tapeworm, that observers of cysticerci in other deer would have hesitated to identify them as *C. cellulosæ*, yet no one appears to have doubted the correctness of such an identification. Even in certain cases in which it was noticed that the hooks did not correspond perfectly to those of *C. cellulosæ* the observer nevertheless concluded that the parasites were actually *C. cellulosæ*. The history of *C. cellulosæ* emphasizes the necessity of guarding against the indiscriminate acceptance of host records. As a general rule records of the same species of larval tapeworm from a variety of hosts should be considered of doubtful correctness unless supported by feeding experiments or other conclusive evidence.

MAURICE C. HALL,
Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

A SPECIAL meeting of the society was held at 4:30 P.M. on March 25, 1913, in room 43 of the new building of the National Museum, the president, Mr. Stetson, in the chair.

Dr. George Grant MacCurdy read a comprehensive paper on "Ancient Man, His Environment and Art."

This paper dealt with the environmental factor in human development; the newly discovered human remains from Piltdown, Sussex, and their significance; recent finds in the terraces of the Somme Valley; San Isidro, near Madrid; Torralba, a large camp site in the province of Soria, Spain, where a rude stone industry associated with an ancient fauna has been found; caves on the Island of Jersey occupied by Mousterian man; typical caves and rock shelters of southern France: La Quina, La Ferrassie, Placard; the art of the cave man in France and Spain: Altamira, Castillo, La Pasiega, Covalanas, Pindal, Font-de-Gaume, Cap Blanc, Niaux, Gorgas, Laussel, Alpera, Cogul; representations of the human form; La Combe, a cave in the Dordogne excavated last summer by Professor MacCurdy; Tuc d'Audoubert, a Pyrenean paleolithic cavern of great beauty discovered last July; its parietal art and the unique figures of the bison modeled in clay; paleolithic art in its relation to magic; some of the causes which led to its development and eventually to its decay.

The lecture is based largely on first-hand observations by the lecturer during the past summer. The lantern slides reproduce faithfully in color the remarkable paleolithic cavern frescoes. The epochs covered by the lecture beginning with the oldest are: Eolithic or pre-Chellean, Chellean, Acheulian, Mousterian, Aurignacian, Solutrean, Magdalenian and Azilian. These are all pre-Neolithic.

Several questions were asked and answered.

W. H. BABCOCK

THE CLEMSON COLLEGE SCIENCE CLUB

THE regular monthly meeting of the club was held on Wednesday evening, January 15. The first paper was by Dr. R. N. Brackett, head of the department of chemistry, entitled "The History of the Clemson College Science Club." There was a great deal in this that was very interesting, as Dr. Brackett presented same in a very entertaining manner and pointed out that the club had entertained and had before it some distinguished men in its history.

The next paper of the evening was by Professor J. N. Harper, director of the agricultural department and of the South Carolina Experiment Station, on the "Mendelian Law." This was treated from the standpoint of his own experiments and observations on this law. He very lucidly gave the history of Mendel and the explanation offered by him for the operation of his law. It is of decided interest also that Professor Harper has done original work along this line and has evolved an explanation for the working of the law that has invariably been borne out in his observations and experiments.

F. R. SWEENY,
Secretary

SCIENCE

FRIDAY, APRIL 18, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE FUNCTION OF RESEARCH IN THE REGULATION OF NATURAL MONOPOLIES[1]

THE social and political unrest of the present day, which manifested itself strikingly in the recent presidential campaign, is of course due to more than one cause. Senator Root, in a notable speech recently delivered before the New York Chamber of Commerce, attributed this unrest in large measure to the mutual distrust and mutual misunderstanding existing between the leaders of the financial and industrial world, on the one hand, and the great body of the American people, on the other. To a large audience of bankers, merchants and captains of industry he said:

> There are hundreds of thousands of people outside our great industrial communities who think you are a den of thieves. There are hundreds of thousands of people who think the bankers and manufacturers are no better than a set of confidence men.
>
> We have before us now great and serious questions regarding the financial problems of the country, and this is what stands in the way of their solution: It is that the men who understand the finances of the country and the merchants engaged in great operations are under suspicion; great bodies of people will not accept what they say about finance. They will not accept what the experts say because they do not believe their motives are honest. . . . On the other hand, what is your attitude toward the people? There are many in this room to-night who down deep in their hearts believe that great bodies of the American people really want to destroy their business and confiscate their property. Now, neither of these things is true; but one misunderstanding leads to conduct which seems to justify another.

[1] Retiring presidential address before the Philosophical Society of Washington.

Senator Root then went on to say that there is nothing more important to-day than that by education and the spread of ideas such misunderstanding shall be done away with; that Americans shall interpret the spirit of popular government so that each shall be ready to do justice to the other, and every American shall desire the prosperity and happiness of every other American.

But while there is great force in what Senator Root says, it remains true that this social unrest springs in a measure from causes which the government can remedy.[2] The part which the government must play in our complex civilization is constantly increasing, and is immensely more important than in the simpler civilization of a century ago. In the early days the individual was much more independent, and each community was much less dependent on other communities than now. Society was simple, communication and commerce were limited, and relatively few laws sufficed. The twentieth century differs from the eighteenth in many respects, but in none more strikingly than with regard to the increasing complexity of business dealings.

The regulation and control of large corporations which have virtually secured the monopoly of particular industries is now receiving the attention of many of our leading scholars and statesmen, and the solution of the problem will be a triumph for popular government. The means that may be employed for this purpose are not so restricted as they formerly were. The public is becoming educated rapidly, and the constitution has greater capacities now than formerly.

STATE REGULATION OF NATURAL MONOPOLIES

While the federal government in the last few years has been striving to break up giant aggregations of corporations into their constituent parts, with the hope of getting these parts to compete with one another and so put an end to an undesirable monopoly, some of the states have been dealing in constructive fashion with another class of monopolies, and showing how they can be regulated and controlled to the end of conserving the best interests both of the public and of the stockholders. I refer to that very large and important class of corporations known as public-utility companies, chief among which are the steam railways of the country, city and interurban electric railways, gas and water companies, electric light and power companies and the telephone and telegraph companies. The federal government through the Interstate Commerce Commission has of course taken a leading part in this development, particularly with respect to the railways of the country, but the work done by some of the state public-service commissions, prominent among which are the commissions of Massachusetts, Wisconsin and New York, is of far-reaching influence and importance.

The attitude of the public regarding public utilities has been undergoing a profound change in recent years. Formerly a franchise for a street-railway or gas company, for example, was usually granted without compensation to the city, with few, if any, obligations on the company, with no control by the city over prices or service, and with extensions of the service into new territory optional with the company. Competition was sometimes sought by granting a franchise to more than one company, but generally such competition, if any, made the service poorer to the public as well as the profits less to the stockholders. If the business was profitable and the franchises valuable, city coun-

[2] In other words, the people acting cooperatively through their chosen representatives can remedy.

cils would be corrupted, if necessary, to get what was wanted. And, if the dividends were large, as they often were when no standards were set as to the quality of service and no limit set as to price, the capital would be sufficiently watered to keep down the dividends (capitalizing the value of the franchise, it was called). Occasionally a city became so dissatisfied with its gas or water or electric light company (either as to prices or service, or both) that in despair it built a new works, and two plants were operated where one, if rightly managed, would have served the public better.

ADVANTAGES OF A MONOPOLY

The change from this condition to the present (at least in certain states) is nothing short of revolutionary. It is now coming to be recognized that competition can not regulate rates in public utilities, and that one company can generally give better and cheaper service than two. It is a waste of capital and a disadvantage to a city to have two sets of gas or water pipes in the ground, or two sets of telephone or electric light wires and poles encumbering the streets. Having two telephone companies in a city forces a large proportion of their patrons to pay for both services; two street railway systems generally give less satisfactory service and fewer transfers than one would do. In short, these utilities are natural monopolies, and the highest efficiency and lowest rates are only possible when each one has the entire business of a given city or territory. So long as the right to regulate public service companies was denied, the idea of granting monopoly privileges was repugnant, and hence competition was encouraged with the hope of escaping the ill effects of unregulated monopoly. But now that the right and duty of regulating all public-service corporations is admitted by the companies themselves as well as by the courts, the ill effects of monopoly may be escaped and at the same time the beneficial results of economy and efficiency may be realized. To understand what effective regulation involves, we must consider the obligations imposed upon public utility companies, and the character of the service rendered by each.

When a community grants an exclusive franchise for a term of years or for an indefinite period to a corporation, with the right to regulate the quality of the service it shall render and the prices it may charge for such service, it undertakes a serious responsibility. The interests of the public must be safeguarded, but at the same time the interests of the company and its stockholders must be respected. A public-service commission, equipped with a full knowledge of the technical, commercial and legal aspects of the business, and endowed with a judicial spirit, will see that the following duties are fulfilled by each public-utility company in its jurisdiction:

1. To perform any duties especially prescribed by law.
2. To serve all who request service and make no discriminations.
3. To provide safe and adequate service.
4. To charge just and reasonable rates.
5. To fulfill its duties to its stockholders honestly and efficiently.[3]

REGULATION OF A GAS COMPANY

For example, a gas company receives a franchise to manufacture and sell gas for light, heat and power in a given city, for a

[3] This of course supposes that the commission has been given the necessary authority by the state legislature. Many of the public-service commissions were created as railroad commissions; and of these, some have had their functions extended to cover only a part of the duties mentioned above.

term of years, the city perhaps to have the right of purchasing the plant at the end of the franchise period. The quality of gas and the character of the service furnished, and the prices charged, are to be fixed by the public-service commission.

The commission must see that the company runs its mains into all the streets of the city, so as to give service to all; that uniform rates are charged and no rebates are allowed to favored customers; that service charges, if made, are reasonable; that the gas is of good quality, and as free from impurities as possible; that its heating value and candlepower are kept up to the standard specified; that the methods of testing and the instruments employed are up to date and satisfactory, and the persons doing the testing are competent; that the pressure of the gas is sufficient and not too great and does not vary enough to be dangerous; that gas appliances used are as safe as can be obtained, and connected in an approved manner; that the mains are properly located and properly protected from extremes of heat and cold; that the meters are kept in good order and tested from time to time as to their accuracy; that the prices charged are as low as possible, consistent with a reasonable dividend to the stockholders; that the books are kept in an approved form, so that the state of the business can readily be determined by the commission; that proper allowances are made for plant depreciation, or proper sums expended for upkeep; that no new stock is sold without approval by the commission, and that all dividends shall be from actual earnings, but that if actual net earnings are more than necessary to pay a reasonable dividend, the price of gas shall be reduced. This usually involves an appraisal of the company's property to determine whether the capitalization is fair. From time to time the specifications for the quality of the gas and the methods of testing must be revised; the question may arise as to what candlepower or heating value will give the best service under prevailing conditions; new methods of manufacture, new appliances and new uses for the gas will all bring up new questions; and the commission must be prepared to consider and decide upon all kinds of scientific, engineering and commercial problems as they arise in connection with the regulation of gas companies.

These duties are so many and so varied that one might suppose that it would be impossible for a commission to accomplish them all even for a single company, much less for all the gas companies in a state. If it had never been done, it would indeed appear doubtful. But these functions are being performed (at least in large part) so successfully in a few states that many of the other states are looking forward to doing it as soon as their commissions are prepared for the work. The gain from such regulation is not alone to the public, which pays for and uses the gas. The company is saved from unfair and hostile local legislation, which often forces resort to the courts, always an expensive and often unsatisfactory experience. The business is more stable, customers are better served and better satisfied, the credit of the company is often improved, new stock sells more readily and at higher prices, as the public knows the condition of the business and there is less risk to the investor. Stock manipulation is prevented, and those who profit by that process are the only ones to suffer.

REGULATION OF AN ELECTRIC LIGHT COMPANY

Similar duties devolve upon a public-service commission with regard to other utilities. Electric-light companies are

regulated with respect to their schedule of rates; discriminations which are so frequent under ordinary circumstances must be prevented; wires, whether overhead or underground, must be run in such manner as to reduce the danger to the public; high-potential wires must be especially guarded to keep them from telephone and other low-potential wires; alternating current transformers must be grounded on the secondary side, and the grounds must be made according to approved specifications; the steadiness of electric potential and uniformity throughout a given city must be satisfactory; proper precautions must be taken to safeguard the lives of the linemen and other employees of the company; the meters must be frequently tested and provision made for extra tests on complaint; portable and station instruments must be tested; lamp renewals must be regulated and prices approved for other than free renewals and rules and regulations made (in the absence of local rules) with respect to street lights.

REGULATION OF OTHER UTILITIES

Street railways and interurban electric railways must be regulated with respect to kind and quality of cars; the speed of cars and car schedules; kind of brakes, headlights, doors and other safety appliances; the method of car heating and amount of heating required; the method of car lighting and the quality and amount of light that must be supplied; how the current is distributed from the sub-stations to the cars, and the variations in voltage permitted between sub-station and cars; how the railway current is returned from the cars to the sub-stations, in order that the resulting electrolysis may do the minimum of injury to gas and water pipes, lead-sheathed cables and other underground structures; the repairs and upkeep of roadway and rolling stock; the fares to be charged and the conditions under which free transfers are issued; the wages paid employees and hours of labor; the conditions under which new stock may be issued; approval of plans for extensions or alterations of the system, etc.

Telephone companies must be regulated with respect to method of running their wires, so as to give the best and most reliable service possible under given circumstances; when and where wires must be put underground; the precautions to guard overhead wires against coming into contact with high-potential electric light or power wires; when and under what circumstances telephone and high-potential electric wires may be put on the same poles; the rates to be charged for different classes of service, both local and long distance; the service arrangements between different companies, the restrictions imposed by telephone companies respecting private exchanges and extensions; discriminations by a powerful company against smaller independent companies, etc.

Both the Interstate Commerce Commission and the state commissions deal with problems arising in connection with the regulation of the railroads, and these problems are numerous and of great importance. The first class of problems is connected with the fixing of freight and passenger tariffs, and discriminations in rates as between one locality and another or between one shipper and another. The second class of problems has to do with the operation of the road, with the safety and the adequacy of the service. This includes the question of the character of the roadbed and rails, the kind and quality of the engines and cars, the brakes and signaling apparatus, the kind of headlights and the candlepower and distribution of the light from the same; the heating, lighting and

ventilation of cars; the investigation of accidents; the weighing of freight and the testing of the scales, including the scales on which empty and loaded cars are weighed. These and many other questions may come before both state and federal commissions, but not all of them have been fully considered as yet by either. Similar duties pertain also to other utilities that are essentially monopolies, as telegraph companies, express companies, sleeping-car companies, water-supply companies, local express, transfer and cab companies. In so far as these utilities carry on an interstate business, they are also dealt with by the federal interstate commerce commission.

COOPERATION NECESSARY IN REGULATION

It appears from the above formidable, although incomplete, list of duties devolving upon a state public-utility commission that to fully measure up to its responsibilities would require a considerable staff of engineers, accountants and scientific assitants, besides its traveling inspectors and administrative officers. To decide many of the questions arising requires more technical knowledge than the experts either of the commission or the utility companies possess. Indeed, many of the questions can only be answered by extended researches carried out by scientists, engineers or statisticians working with the best of facilities. The interests at stake are in the aggregate so great that such researches ought to be made, and yet the cost would be too great for every state to do the work independently, or even for the richest of the states to undertake it alone.[4] The best way in which the work can be well done and kept up to date is for all the states to cooperate, and for the federal government to assist and coordinate the work. This is being done to some extent already, although comparatively few of the states as yet have commissions that are handling public utilities generally, and hence the work is only fairly begun. On the part of the federal government, the Interstate Commerce Commission and the Bureau of Standards are cooperating with the state commissions, the latter with regard to standards and engineering questions which fall within its province. Some of these questions may be mentioned briefly.

INSTRUMENTS AND STANDARDS

The instruments and standards employed in the measurement of heat, light and electrical power have been the subject of much study and investigation at the Bureau of Standards. The thermometers and pyrometers of various kinds employed in temperature measurements, and calorimeters of different types for use in measuring the heat of combustion of gases and solids, are calibrated and certified by the bureau, and standard samples of certified calorific value are furnished, so that the testing apparatus of public-service commissions, public-utility companies and consulting engineers will agree (or special tests be made if they disagree) and causes

[4] Extract from Professor R. T. Ely in his "Outlines of Economics," 1908:

"The tasks which confront such commissions are stupendous, and the expense of conducting their work, when it is properly conducted, is enormous. . . . On the whole, however, it is fortunate that the public have resolved to give this method of reform a thorough trial. It seems to be the next logical step in the evolution of natural monopoly, and does not appear to be attended with any grave danger. If it fails it will at least have trained up a corps of public servants thoroughly familiar with the operation of public-utility enterprises, and will at the same time have thoroughly convinced the people that there is no other alternative but public ownership and operation." This was written five years ago, and much progress has been made since then.

for dispute are thereby removed. The methods of testing with such apparatus have been studied by the bureau and sources of error in apparatus and methods determined. As manufacturing methods are developed and refinements in works control are introduced, greater accuracy in testing is required, and it is a great advantage to the industries to have uniform and reliable instruments, standards and methods.

The same may be said respecting the measurement of light and illumination. The candlepower of a gas flame depends upon the quality of the gas, the kind of burner used, the height of the barometer, the amount of moisture in the atmosphere and the degree of purity of the air in which it burns; hence, if the quality of the gas is to be determined (in part) by the candlepower given, it is necessary that the test be made under very definite conditions. The bureau has done considerable work on flame standards employed in gas testing, but much remains to be done in this respect. Photometric standards are supplied by the bureau for use in testing electric lamps of various kinds and colors, and gas standards are calibrated and certified. Thus, uniformity of value in light measurement is secured for the whole country, and indeed by means of international comparisons made by the bureau for the whole world, the international candle being the name of the unit of light universally employed in this country. Calibrations are also made of photometers and auxiliary apparatus. Similar uniformity, together with a much higher degree of precision, have been attained in electrical measurements. Electrical energy is sold by the kilowatt hour or the kilowatt year (or a combination of the two) and a large amount of testing is done by the companies and commissions to insure accurate measurement of the energy delivered. Here again uniformity and accuracy are promoted by having a national laboratory for calibrating and certifying standards and instruments, and settling such disputes as may arise from disagreeing measurements. A large amount of work has been done by the bureau to secure and maintain accurate standards and instruments, but much remains to be done, particularly with reference to the specifications of instruments and apparatus and the improvement of methods of measurement and testing.

In addition to its work on instruments and standards, the bureau has carried out other investigations which have a bearing on the work of the public-service commissions. One of these is concerned with the specifications of illuminating gas, and the methods of testing to be employed in controlling its quality.

REGULATION OF GAS COMPANIES

Among public-service utilities, none has been for so long a time and in so great detail subject to legal requirements and restrictions as the gas business. Such regulation is of course intended to insure good service. Many elements go to determine good or poor service, the principal of which (chemical purity, heating value, candlepower and condition as to pressure of the gas) are enumerated and defined more or less completely in many of the gas ordinances now in force, together with the tests that shall be made and the penalties for failure to meet the requirements. These ordinances are sometimes, therefore, very technical and contain detailed specifications. In other cases the specifications are very meager. In some cases old ordinances long since out of date, so far as their technical specifications are concerned, are still in use; in other cases, old ordinances have been extensively amended; in

still other cases entirely new ordinances have superseded old ones; in many cases no regulatory ordinances have ever been adopted. In some states possessing state commissions, the requirements have been fixed by the commissions. But in most states (and in all until recently) regulatory ordinances have been prepared and passed by state legislatures or city councils. The process of adopting such an ordinance is often long and painful. Suspicion, antagonism and often political considerations combine to make the negotiations difficult, and sometimes it amounts to a long-drawn battle. The representatives of the city endeavor to get all they can for the public, the company yields as little as possible. The result is generally unsatisfactory to both. Because the standard of performance demanded of gas companies in different cities and states was so different, and because so much difference of opinion existed among experts as to what could fairly be required of a gas company under given conditions, the Bureau of Standards took up about three years ago a careful study of the subject of state and municipal regulations of the quality, purity and pressure of illuminating gas supplied by gas companies.

INVESTIGATION CONCERNING REGULATION OF GAS COMPANIES

A compilation of all the state laws and city ordinances in force in the country was first made, and their technical requirements tabulated. A detailed study was then undertaken of the various features of such laws, and an attempt made to formulate a model law that should contain reasonable standards of quality, purity and pressure, and a reasonable set of operating requirements. In this study, a large number of the best informed gas experts in the country were consulted, and many gas plants visited. In this work the bureau has been assisted by the responsible officers and members of the technical staffs of gas companies and by members of public-service commissions, gas inspectors and consulting engineers. The bureau has endeavored to consider all sides of the various questions involved, and has of course received very conflicting opinions on some questions. It has been a source of great gratification to those conducting this investigation to see the fairness and broad-minded spirit shown generally by representatives of the gas companies in discussing questions that affected them so vitally. They have met a spirit of fair play by a corresponding willingness to reach just conclusions.

The results of this investigation were published by the Bureau of Standards, and the paper has had a wide circulation and careful study by those most interested in the subjects treated. Since its publication, the bureau has continued to study the subject, and is now preparing a revision of the first edition. The compilation of laws and ordinances will be revised and some important changes will be made in the model ordinance proposed. These changes are, however, being discussed very fully before publication, both with representatives of the public-service commissions and of the gas companies, the latter including a special committee of the American Gas Institute.

The position of the bureau in this matter, as in so many others, is advisory. It has no authority to enforce its conclusions and no disposition to suggest federal legislation or regulation. It acts as an unbiased coordinating agency, to formulate the results of its own and others' investigations and to give expression to the consensus of opinion of those best qualified to

express opinions on technical questions of great practical importance.

A second investigation (already alluded to) is in progress on the methods and instruments employed in testing gas for its heating value, its candlepower and its chemical purity, as well as in testing meters and measuring gas pressures. This will be embodied in a separate publication which will be frequently revised and kept up to date, in order to be as useful as possible to gas inspectors and engineers in determining whether gas meets the specifications under which it is sold.

A third investigation scarcely begun, but which is much needed and deserves extensive study, is on the safety and efficiency of gas appliances. Too many fatal accidents result from defective gas appliances, and the contamination of the atmosphere through imperfect combustion due to defective appliances is a serious matter, even when no fatalities result. This is a question in which cooperation of all the interests concerned can not fail to yield important results.

INVESTIGATIONS OF ELECTROLYSIS

Another important investigation carried out by the Bureau of Standards, which also concerns public-utility companies, is the damage by electrolysis produced by street railway currents flowing through the earth, upon gas and water pipes, lead-covered cables belonging to telephone, telegraph and electric-light companies, and the reinforced concrete foundations of buildings and bridges. Such insulated double conductor systems as those of New York, Washington and Cincinnati provide for the return of the current to the power houses without flowing through the earth, but most cities use the single overhead trolley, and permit the current to return in part through gas and water pipes and other underground conductors. Where the current leaves such metal conductors, the latter are corroded electrolytically, and in some cases holes eaten through, thereby interfering with the service and involving expensive repairs. Many remedies have been proposed, but as yet comparatively little has been done to cure the evil. The bureau undertook a thorough study of the question for the purpose of testing some of the proposed remedies and arriving at a solution of the difficulty, if possible, that could be applied generally. This investigation is not yet completed, but already valuable results have been reached and it is hoped that shortly information will be made available for the use of the street railways that will permit them greatly to reduce the volume of the currents flowing through the earth without unreasonable expense, and that will enable the public-service commissions to deal more intelligently with the question. The problem is becoming each year more acute, since the volume of electric current used is each year increasing as the traffic increases, and the damage produced is therefore increasing at an increasing rate. Many lawsuits have arisen because of this damage, and such litigation is expensive because of the large amount of conflicting expert testimony adduced and the long time consumed in the trials. Money expended intelligently in solving the problem generally yields better returns than money spent in litigation.

In England and some continental countries there have been rules on this subject which have served as a guide to the electric railways in building their roadways, and hence they have been saved very largely from the evil effects of electrolysis, although at a somewhat increased first cost. In this country the subject was neglected for years. In the absence of public-service

commissions or similar bodies to establish regulations, and no government agency to take the lead in the investigation, the matter has been entirely neglected in many cases until the serious damage resulting has made the question a very acute one.

LIFE HAZARD IN ELECTRICAL WORK

Another question affecting public-utility companies is the life hazard in electrical work. There are altogether too many preventable fatalities due to high-potential electrical circuits, not only to employees of the electrical companies, but also to the public. In many cases such accidents could have been avoided if the companies had taken greater precautions, either by instructing their employees more carefully, or providing them with rubber gloves and other protective devices, or having repairs made only on dead lines, or using more substantial and more expensive construction, or running the high-potential transmission lines on private rights of way instead of on the highway, or keeping the dangerous wires away from telephone wires and on separate pole lines, or taking still other precautions which experience shows are necessary. The long-distance transmission of power is being resorted to more and more, and higher voltages are being used than a few years ago would have been thought possible. One thousand volts is a dangerous voltage, but transmission at fifty to a hundred thousand volts is becoming common. As water power is utilized more and more, the country will finally be covered with a network of high-potential transmission and distribution lines, and it is a matter of vital concern that all reasonable precautions be taken in the construction and operation of such lines. So long as public utilities were regarded as private business and a company was free to make as much money as possible and invest as little as possible in its plant, the tendency was to economize unduly with respect to protective devices, and any construction that was more expensive than the mechanical or electrical requirements demanded was avoided. But when we regard railroads, electric light and power companies and telephone and telegraph companies not only as public utilities, but as quasi-public institutions, and permit them to charge enough to make a good profit, but to make the rates as low as good service permits, then it is seen that the public pays for the cost of protection, and it is entitled to require that every reasonable precaution be taken to safeguard human life. This latter is the view which is now becoming general, and the public-service commissions are therefore greatly interested in having rules and regulations worked out in such a way as to be capable of enforcement upon the electrical companies. On the other hand, the electrical companies themselves are anxious for such information. It is not necessary to make original investigations in every case; it is often a question of collecting and digesting the information already in existence, and with the cooperation of numerous agencies which stand ready to assist, work out a body of rules and regulations that will be as useful as possible. Congress has recently made a special appropriation to permit the bureau to undertake such a study of the life hazard in electrical work, and it is hoped that valuable results may be accomplished.

RAILROAD SCALES

Another investigation of great practical importance, in which the Interstate Commerce Commission and the Bureau of Standards are cooperating, is the investigation of the accuracy of railroad scales, especially car scales, for weighing freight.

Freights to the amount of two thousand millions of dollars are annually collected by the railroads on weighings made with scales, most of which are seldom tested and, except in three western states, never officially inspected. Numerous disputes and complaints could be avoided if the scales were officially tested and certified, and if provision were made for retesting on complaint. Certainly, it is as important to test large scales as small ones, and the cost of doing so is trifling in comparison with the enormous interests at stake.

LOCOMOTIVE HEADLIGHTS

Another subject with which some of the state commissions have dealt is the kind of headlights used on locomotives, their candlepower and reliability. In some states legislation has been enacted requiring a particular kind of headlight. It has been charged that such legislation in some cases has been inspired by commercial interests. In one state the commission issued a rule requiring a certain candlepower, but not specifying how it was to be measured or exactly what was meant. The railroads, contending that the order was ambiguous, impossible to comply with by one interpretation and undesirable by another interpretation, appealed to the courts. After a lengthy and expensive litigation the order of the commission was set aside. This case is cited to illustrate the need of technical information by state commissions before issuing mandatory orders, and also the hardship to railroads or other public-utility companies to be obliged to contest in the courts orders that work a hardship and which would not have been issued if full information had been at hand. There is great need of further investigation of the subject of headlights for use on steam and electric railways, to determine the best service that different types are capable of giving, and to formulate rules that could be enforced by the commissions. Some railroads economize unduly on the maintenance of headlights; in the interest of safety to the public, wise regulations should be in effect.

CAR LIGHTING

The lighting of cars (both steam and electric) is another practical matter that has not received the attention that it deserves. Most people read more or less on trains and street cars, and with many who ride a long distance to and from business this is their best time for reading. As a rule, however, the lighting of cars is insufficient and the arrangement of lights is often atrocious from the point of view both of the passengers who are not reading and those who are. Eyesight is too precious a possession and too easily injured to justify the continuance of poor lighting of cars. Better light is required than would be necessary if the cars were not moving. The problem is different on electric cars from what it is on steam cars, because in the former the current for lights comes from the same circuit that supplies the motors, and hence great variations occur due to the fluctuating voltage on the trolley wire. To secure better lighting, (1) a steadier voltage should be available, (2) better lamps should be used than are generally seen in electric cars, (3) a greater quantity of light should be available and (4) the lamps should be so shaded and so located as to keep the glare out of the eyes of the passenger, and yet give good illumination for reading. The immense importance of this subject can only be realized when one considers the millions of people who daily spend considerable time in steam or electric cars, and how much better the service would be if the cars were pleasantly and sufficiently lighted. The

public-service commissions have it in their power to effect an immense improvement in this respect, but first a thorough investigation should be made, with the cooperation of the railroads, to show what are the best methods to follow, and what it is practicable to accomplish with present resources.

HEATING AND VENTILATION OF CARS

Another question of great practical importance is the heating and ventilation of cars, including Pullman sleeping-cars. Any person who has sweltered in an overheated, unventilated lower berth of a sleeping-car (and who has not), will allow that there is great room for improvement. Surely the resources of American invention have not been exhausted in this direction, nor, indeed, with respect to heating and ventilation of day coaches. It is one of the functions of public-service commissions to see that the health and comfort of the public are kept in view by the utility companies, and if it can be made clear what should be done in this respect, the way to reform is open.

RAILWAY ACCIDENTS

Another line of work which deserves an immense amount of investigation and study, and cooperation between the states and the federal government, is the prevention of railway accidents. Much has been done and is now being done, both by federal and state agencies, and by the railway companies; but far greater sums of money might well be expended by the states and the federal government in a systematic investigation of all phases of this question. It is nothing short of a national disgrace that American railways should kill and injure so many more people than do the railways of European countries, even where the speeds are as high and the passenger traffic as heavy. Life is too cheap with us, and the penalty for disasters too slight. The causes of these accidents are partly physical and partly psychological; no doubt greater attention given to the subject of how to prevent both kinds of accidents would be abundantly rewarded.[6]

Other subjects deserving research could be named that fall within the province of the public-service commission, but enough has been said to show how important are their functions apart from the duty of fixing rates and preventing discrimination. These illustrations show how much better it is for the public as well as the companies that the commissions regulate by cooperating with and assisting the companies instead merely of dictating to them what they shall do or shall not do; that the scientist, the engineer and the statistician are more useful to them in their work than the lawyer; that the bar of public opinion is more effective than the courts in enforcing their decrees. Many of these utilities are operated by big corporations, owning scores of plants in many states; in the case of the telephone and telegraph, they are gigantic systems operating over the whole country. It is therefore important that the rules and regulations in the different states shall be as nearly uniform as possible. Hence, in order to reach wise and just conclusions, and to secure uniformity,

[6] A recent writer states that 19,377 more persons were injured on railroads in the United States in 1912 than in 1911, and commenting on the slight amount of scientific information that has been collected regarding the causes of accidents, he adds:

"The railroads of this country carry so many passengers and so much freight that in one year they are able to charge three billion dollars for the service. And yet it is admitted that no accurate engineering data showing the actual stresses which are set up in railway structures by locomotives and cars of different weights and moving at different speeds has ever been gathered."

it is important that the states cooperate with one another, and the federal government can serve as a valuable aid and coordinating force in this cooperation.

The results that are being attained in this way are only beginning to be realized. They will be of invaluable benefit, not only to the public served, but to the companies themselves, and to the cause of good government. With the utility companies under the control of business-like state commissions, the business is better managed,[6] discriminations in rates are eliminated,[7] the utilities are taken out of local politics and the possibility of pure municipal government in America is enormously enhanced.[8]

One of the best results of the method of regulation by public-service commissions is the publicity it secures of the affairs of the company and the confidence it establishes in the public mind in the various utility companies. The suspicion and distrust which Senator Root emphasized so strongly in his New York address is everywhere felt toward these companies when their affairs are kept secret, and especially when the service is poor and the dividends good. Controversies arise which sometimes degenerate into bitter and partisan feuds. Who can feel kindly toward the management of a street railway company if he is usually compelled to ride as a strap-hanger, or toward a gas company if the rates are excessive or he believes that his meter races, or toward any company that appears to regard its franchise as the deed to a private monopoly. If the service is improved or the rates reduced as the business grows more prosperous, the people as well as the stockholders derive benefits from success. The public soon realizes that utilities so conducted are in effect partnerships between the public and the stockholders, and are willing that the latter receive increased dividends with increased prosperity if the public is permitted to share the fruits of success. The sliding scale of prices for gas is a successful example of this system, but it is also realized in many cases where a sliding scale of prices has not been fixed in advance. The regulation of prices by a commission gives

[6] B. H. Meyer, speaking on the Wisconsin Public Utilities Commission at the Pittsburgh meeting (1908) of the National Municipal League, said: "The utility law is working a revolution in business management. . . . Many of the utility companies have not been operated on a business basis; in fact, it is probable that a good many of the managements did not have the remotest idea as to the exact standing, from a business point of view, of the plant they were operating. Uniform accounting and rules governing the service and the regulation of rates, compel the adoption of business and scientific methods. This is resulting in *nothing short of a revolution in management.*"

[7] The whole state of Wisconsin was literally streaked and plastered with discrimination in the rates of utilities, and in all the rest of the country, where the extent of the discriminations have not yet been determined, as they have been in Wisconsin, it is quite probable that discriminations similar in character and extent likewise exist.

[8] Governor McGovern has this to say regarding the utilities and politics in Wisconsin:

"Times were in Wisconsin when the railroads ran or tried to run the government of the state, and the minor utilities sought to boss the cities, towns and even villages. They contributed liberally to campaign funds, urged their supporters and lobbyists to become candidates for public office, and in close election districts colonized voters in the old conventional way. Now, one and all, they are in this sense absolutely out of politics. There is, indeed, no reason now why public-service corporations in Wisconsin should wish to dabble in public affairs. Their relations to the people of the state have been definitely and finally determined. They no longer have anything to gain or lose by intermeddling in politics, and apparently they have decided to retire for good. What the elimination of public-service corporations from participation in political campaigns signifies in the purification of public life, no one here needs to be reminded."

in effect a sliding scale, by which either the price goes down or the quality of the service goes up, as the success of the business justifies it. For want of a public-service commission in the District of Columbia, the Interstate Commerce Commission has recently been exercising the functions of such a commission with respect to the street railways, and with good effect. There is great need of a full-fledged public-service commission in the district, and it is hoped that Congress in its wisdom will respond to public sentiment and establish such a commission.[9]

How infinitely better is this method of regulation than the building of publicly-owned utilities to compete with private plants already in existence. For a state or city to say that it is impotent to regulate a public utility is a confession of weakness; but there is far greater difficulty in city control than in regulation by state commissions. Except, perhaps, in the largest cities, it seems much better to have strong state commissions, well equipped with technical assistants, than to have separate commissions for each city. And with the cooperation of other states and the federal government, any state commission can establish its work with only a fraction of the effort and expense required by those states that have pioneered the movement.[10]

Turning now to the great industrial and financial corporations popularly called trusts, the question suggests itself whether it is possible for the government to regulate them in a manner similar to the regulation of the natural monopolies we have been discussing, so that full publicity may be secured, the rights of the public may be conserved, and at the same time the rank and file of the stockholders will be protected from the vultures that often hover over the executive offices of such concerns. One can not say that it will be done as easily, but it is coming to be believed that the general method adopted in the regulation of public utilities is the right one, namely, less dependence on law and the courts, and more dependence on engineers, statisticians and business experts; that the government should prescribe affirmative duties for the giant corporations, and not merely negative ones; that a constructive policy that would benefit both the business concerns and the public they serve should be sought, rather than a retrograde policy that is no benefit to the business and does no good to the public. If such regulation could be realized, and consolidations and promotions in business could be limited to such as would benefit both the public and the stockholders, and not merely big financiers and promoters, it would be a notable achievement in our political as well as economic history. It would assist mightily in the peaceful settlement of industrial disputes and in the bringing about of a better understanding between capital and labor.

It is just as reasonable to expect the government to perform this function of regulation of monopolies as to expect it to adjust international disputes by arbitration rather than by war. It is not socialistic, but rather the reverse, for it is the alternative of state ownership. In Germany the cities are great business concerns operated by business men for the benefit of the people, and as such they are models for the whole world. They own and operate most of the public utilities themselves, and do it well, and hence the necessity of public regulation is there less

[9] A public-utility commission for the District of Columbia has been established by Congress since this address was delivered.

[10] Writing in 1908, Professor Ely said: "States having commissions empowered to enforce uniform accounting will constitute great economic laboratories in this connection during the next quarter of a century."

felt, although it has been practised for many years. But in this country, municipal ownership has been less successful, except in the case of municipal water supplies.

There have been three stages in the modern history of natural monopolies. In the first they went unregulated, being operated for the profit of the owners and exploited for the benefit of financiers. In the second stage, regulation was by legislation and lawsuit. In the third, regulation is by commission; the regulation is more complete, as well as more intelligent, and cooperation and publicity are keynotes of the method.

The large industrial corporations which have virtual monopolies, are mainly in the first stage, although some are in the second. Whether they will finally come to the third stage, and be regulated by the methods now applied so successfully to natural monopolies, remains for the future to determine.

If state regulation of natural monopolies becomes as general within a few years as it promises to be, and if it is as successful generally as it has been in the few states which took it up first, it will solve the problem of public utilities and largely solve the problem also of good municipal government.

The signal success of the Wisconsin Commission was largely due to the influence of the University of Wisconsin. In its personnel and methods it was a scientific commission, and entered into its work with the spirit of investigators. Its spirit and its methods have been adopted by some of the other state commissions, of which a large number have been created recently and are now taking up their work.

If the administrative officers of the commissions are assisted by scientists, engineers and economists, and the work is done in a judicial spirit, as new problems being taken up as a scientific research would be, the states and federal government acting in full cooperation, with the experience of each available to all—if the work is done in that way we may be certain that success will be sure and permanent.

Edward B. Rosa
Bureau of Standards

THE NINTH INTERNATIONAL CONGRESS OF ZOOLOGY AT MONACO

Under the presidency of Prince Albert I. of Monaco, the congress was formally opened in the beautiful Museum of Oceanography on March 25. In his opening address the prince, after referring to the basic importance of the study of marine life and the conditions under which it exists, for one who desires a reasonable conception of the problems of biology, spoke of the prime value of the study of zoology as an aid in the solution of many of the problems confronting human social groups. He very cleverly pointed to the Principality of Monaco as a community where the life of the people is illumined by the light of science, and where the climax of all the activities of the state is a noble scientific institution devoted, not only to the investigation of the deep sea and its life, but to the application of the facts thus discovered to the daily life of the people.

For the reading of papers the congress was organized into eight sections, which, with the number of titles on the program of each, were as follows:

I. Comparative Anatomy and Physiology. 32 titles.
II. Cytology. General Embryology. Protistology. 25 titles.
III. Systematic Zoology. Behavior. 26 titles.
IV. General Zoology. Paleozoology. Zoogeography. 13 titles.
V. Oceanic Biology. Plankton. 8 titles.
VI. Applied Zoology. Parasitology. Museums. 15 titles.
VII. Nomenclature. 9 titles.
Sub-Section VIII. Entomology. 10 titles.

Three general sessions were held, upon the

programs of which there were thirteen additional titles.

An American zoologist could not fail to be struck with the relatively small number of titles lying in the experimental phases of zoology, and so complete has become the divorce between continental zoology and genetics that the program of the congress contained but two titles within the latter field.

The topic subtending the widest angle, both in informal discussion and in the business of the congress, was that of nomenclature, more specifically, the advisability of continuing the application of the rule of priority adopted by the International Commission on Nomenclature. This question was discussed first in the section on nomenclature, where the opinions of American zoologists were presented chiefly by Dr. Stiles, Professor Williston and Dr. Field. The section first resolved to recommend to the congress the proposal of Dr. Field, that an author might, in special instances, present to the commission a request that a name be established although not in accordance with the strict priority rule. Such cases were to be transmitted to a sub-committee of specialists and to be published before their adoption. If the commission were unable to accept the decision of the sub-committee, an appeal might then be had to the congress at its next meeting.

Later, however, the section on nomenclature reversed this action and made a recommendation which was finally presented to the congress and adopted by a large majority. A precise statement of this action will doubtless be published later, but in substance it is as follows. The International Commission on Nomenclature is given full power to suspend the rules of nomenclature, including that of priority, in special cases presented to it by authors, with the understanding that the commission will confer with specialists in the groups concerned before coming to a decision. If then, the vote of the commission should be unanimous, the suspension of the rule in that case becomes effective immediately; if two thirds of the commission favor the suspension, the question is to be laid before a special committee of three, to be appointed by the president of the section on nomenclature, at the subsequent meeting of the congress, this committee to consist of one member favoring the suspension, one opposed to it, and a third, whose opinion has not been formed.

The result of this action is primarily to free the commission from the obligation of a strict adherence to the application of the priority rule. Whether this action will permit a reasonable flexibility in the interpretation of the rules of nomenclature, of course remains to be seen. To many it seems regrettable that so much of the time and work of these congresses must be devoted to the discussion of so special a topic, and one so indirectly related to the advancement of zoological knowledge.

At the last general session on March 29, the award of the Emperor Nicolas II. prize was made to Professor Ernst Bresslau, Strassburg, for his work on the mammary organs of the lower mammals, and to Professor Th. Mortensen, Copenhagen, for his investigations of the invertebrates of the Arctic oceans. The O. Kowalewsky prize was awarded to Professor Paul Pelseneer, Gand, for his well-known work on the phylogeny of the Mollusca. At this meeting Budapest was selected as the place of the tenth congress, in 1916, and Professor G. Horvath, of the Hungarian National Museum was elected president of that congress.

The social events of the congress were especially brilliant, thanks to the hospitality of Prince Albert I., and these added to the wonderful natural beauties and charms of Monaco, combined to render the congress a memorable occasion.

The congress was very largely attended, the enrollment of members reaching approximately seven hundred, a considerable number of whom were, however, not able actually to be in attendance. While the date of the ses-

sion was particularly favorable for European members, a general attendance of American zoologists was practically impossible.

Following is a list of the members present from North America:

Dr. J. A. Allen, American Museum of Natural History. "Individual variation in musk oxen."

Mr. E. Phelps Allis, Menton.

Professor and Mrs. Ulric Dahlgren, Princeton University. (*a*) "A remarkable polarity in the motor nerve cells of the electric apparatus of *Tetronarce occidentalis.*" (*b*) "Embryonic history of the electric apparatus in *Gymnarchus niloticus.*"

Dr. and Mrs. H. H. Field, Concilium Bibliographicum, Zurich.

Miss Katherine Foot, New York City. "Results of crossing three Hemiptera species with reference to the inheritance of an exclusively male character" (with Miss Strobell).

Professor F. H. Herrick, Western Reserve University.

Professor and Mrs. W. E. Kellicott, Goucher College.

Dr. and Mrs. Leonard Stejneger, Smithsonian Institution.

Dr. and Mrs. C. W. Stiles, U. S. Bureau of Public Health. "The distribution of *Necator americanus* in the United States, its medical and economic importance and the campaign for its eradication."

Miss E. C. Strobell, New York City.

Professor S. W. Williston, Chicago University. (*a*) "The Amphibia and Reptilia of the American Permo-Carboniferous." (*b*) Communication on "Nomenclature."

Professor and Mrs. R. Ramsey Wright, University of Toronto.

Wm. E. Kellicott

THE TARR MEMORIAL WINDOW

On March 23, 1913, a memorial window, by Tiffany, was unveiled in Sage Chapel of Cornell University. It was given by Mrs. Tarr and accepted, for the university, by acting president T. F. Crane. The presentation and description of the window, by Lawrence Martin, follows.

This memorial window, dedicated to the late Ralph Stockman Tarr, is given by Mrs. Tarr to Cornell University. Thus the present and future generations of Cornell students and of worshipers in this chapel will be reminded of one who was a faithful and inspiring teacher and a great scientist. During the score of years through which he was professor of dynamic geology and physical geography at Cornell University he made a deep impression upon the minds and in the hearts of those of us who were so fortunate as to come in contact with him in the home, in the lecture room or laboratory, or in God's great outdoors.

The memory of Professor Tarr is fresh with all of those present. It is just a year since we were gathered here to pay our last respects at his funeral. Upon this Easter afternoon and in presenting this memorial window I may perhaps be permitted to say briefly some of the things with which all our hearts are filled.

Professor Tarr's life was a wonderful example to young men. I may speak of his determination to get an education, a determination which led him to enter Harvard University and to work his way through college, and, in the early years, even to travel sixty miles each day to and from his recitations while he lived at his parents' home.

I may speak of his hard work while he was a professor at Cornell, sparing no pains to make his lectures and his laboratory and field work clear, interesting, disciplinary and scientifically sound. The hundreds of students who have taken Professor Tarr's courses are the best fruits of this work, for none of them but gained with their knowledge of geology and physical geography a sense of admiration and affection for the teacher.

I may speak of the imparting of his knowledge of the facts of geography to the hundreds of thousands of readers of his books—books which were written with the utmost regard for truth and for the upbuilding of character by the example gained in learning how one's fellow men are utilizing the great resources of the earth and adapting themselves to the diverse environments in which the Almighty has placed them.

I may speak of his years of investigation. Professor Tarr was always a student. The success of his teaching and of his writing of

books depended largely upon the almost incessant travel in which his summer vacations and sabbatical years were spent. In every state in the union, in most of the countries of Europe, in the West Indies and Central America, in Greenland, in Spitzenbergen, in Alaska, Professor Tarr studied. For he traveled not as a sightseer but as a student, as one who would learn the secrets of nature that he might impart them to others. Work and service. These were the keynotes of his life.

The window which has just been unveiled on the south side of Sage Chapel is typical of Professor Tarr's life of work and service. It represents the valley of a river. In the background rise the mountains, capped by the eternal snows, perhaps containing, in their valleys, glaciers such as Professor Tarr made his especial study. Here is the source of the river, which flows steadily because it is fed by the rain and by the melting snow of the mountains, the pure snow which typifies the innocence of youth.

In the middle distance the river is flowing through a broad, open valley, a valley which has been made by the river itself, a valley which, by the erosive action of the stream, is being made broader and therefore more suitable for habitation by man. The river must widen and deepen its valley, it must carry away the material which is here an encumbrance, but which the river will later deposit on the lower land where it will be of most use to man.

In the foreground the river is in a narrow gorge. This stream has encountered a temporary obstacle in its course. To remove this it uses the very material which it is carrying forward to the sea. Soon it will widen the gorge into an open valley like that of the middle distance. Work is necessary in accomplishing this, hard work in order that the valley may have gently-sloping walls upon which man may plant his fields and in order that the stream bed may slope gently so that the river may do its service in carrying the products of the fields to the markets and towns.

Now most rivers also have lower courses, places where there are broad floodplains and deltas, where the river has deposited rich soil, carried down from the mountains, where the river flows slowly, its hard work nearly done. As in the life of rivers with hurried course and hardest tasks in the youthful section near the mountains, and leisurely current and little work near the mouth, where the river terminates in the all-embracing ocean, so with man. Only in the case of Professor Tarr the river which typifies his life shows no leisurely old age. You will recall that he died on March 21, 1912, at the age of forty-eight. His was a life of hard work, of toil and service. But although he was not permitted to enjoy the years of less strenuous labor, the effort was not in vain. We, his relatives and friends and students, will profit largely, throughout the years to come, by the work which he has placed at our service.

May this memorial window which I now, on behalf of Mrs. Tarr, present to Cornell University ever recall the memory of the work and service to others that was performed here by Ralph Stockman Tarr.

SCIENTIFIC NOTES AND NEWS

AT the semi-centennial celebration of the National Academy of Sciences to be held next week, the medals and prizes of the academy will be presented by the president of the United States. The first award of the Comstock prize, of the value of $1,500, will be to Professor R. A. Millikan, of the University of Chicago, for his researches on the charge of the electron, the ratio of electric charge to mass and gaseous ionization. The Henry Draper medal has been awarded to M. Henri Deslandres, director of the Astrophysical Observatory at Meudon, for his researches in solar and stellar physics.

THE Henry Phipps Psychiatric Clinic, of the Johns Hopkins Hospital, established and erected by Mr. Henry Phipps, of New York, to promote the study of mental disease and its early treatment, was dedicated on April 16, and the exercises will continue during the two following days. Addresses were announced

by Sir William Osler, Professor W. MacDougall, Professor E. Bleuler, Dr. F. W. Mott, Professor O. Rossi, Professor Heilbronner, Dr. Achucarro and a number of leading American psychiatrists, including Professor A. Meyer, the director of the clinic.

THE first lecture on the Joseph Leidy Memorial Foundation was delivered at the University of Pennsylvania on April 17 by Professor Edmund Beecher Wilson, Columbia University. A tribute was paid, on this occasion, to the life and services of Joseph Leidy, the student, teacher and investigator, by Professor Charles Sedgwick Minot, Harvard University.

A MEETING in commemoration of the life and work of the late Dr. John Shaw Billings, late director of the New York Public Library, will be held in the library building on April 25.

KING VICTOR EMMANUEL presided on March 27 at the inauguration of the International Geographical Congress, Rome.

THE National Geographic Society has voted $20,000 to the Norwegian Polar Expedition, which will leave the Pacific coast under command of Captain Roald Amundsen in June, 1914, to explore the polar basin. The voyage, it is expected, will require four years' drifting in the polar ice.

DR. DAVID SHARP, Lawnside, Brockenhurst, Hants, England, and Dr. J. H. Fabre, Serignan, Vancluse, France, were chosen on April 3 as the first two honorary members of the Entomological Society of Washington. The Entomological Society of Washington may elect ten honorary members from among foreign entomologists.

WE regret to learn that Professor Willet M. Hays, assistant secretary of agriculture, under the Roosevelt and Taft administrations and formerly professor of agriculture in the University of Minnesota, is suffering a serious nervous breakdown and is taking treatment at a sanitarium near Washington. Professor Hays had recently accepted a commission from the government of Argentina to reorganize the rural educational system of that republic, but his illness will make it impossible to assume the duties.

DR. L. A. BAUER sails from New York on April 22, to be gone for about two months, in order to arrange for cooperative magnetic work between the Department of Terrestrial Magnetism and various foreign institutions. On May 22 he will deliver the Halley lecture on "Terrestrial Magnetism" at the University of Oxford.

PROFESSOR H. T. BARNES, of McGill University, will accompany the government steamer *Montcalme* to patrol the entrance of the Gulf of St. Lawrence, to report the presence of icebergs. Professor Barnes will use his microthermometer to detect the presence of ice.

PROFESSOR H. T. FERNALD, of the Massachusetts Agricultural College, sails for Europe the last of April, for study in various European museums. He will return about the middle of September.

A JAPANESE translation of "The Elements of Statistics," by Wilford I. King, of the economics department of the University of Wisconsin, has been made. The book has just passed through its second English edition.

DR. LAFAYETTE B. MENDEL, professor of physiological chemistry in the Sheffield Scientific School of Yale University, addressed the students of the Pratt Institute in Brooklyn, on April 11 on "Nutrition and Growth."

ON April 7, before the Southern California Academy of Sciences, Los Angeles, Dr. D. T. MacDougall, director of the department of botanical research of the Carnegie Institution, delivered an address on "Some Physical and Biological Features of American Deserts."

DR. H. L. FAIRCHILD, professor of geology in the University of Rochester, delivered a lecture at Syracuse University under the auspices of the Syracuse Chapter of Sigma Xi, on the evening of April 11. He took for his subject "Remarkable Glacial Drainage Features about Syracuse."

PRESIDENT CHARLES R. VAN HISE, of the University of Wisconsin, delivered an address on "Waste in Distribution" before the first

National Conference on Marketing and Farm Credits, held in Chicago on April 8.

THE New York Academy of Sciences will hold a reception on April 21, when an illustrated lecture will be given by Professor Bergen Davis, of Columbia University, on "Electricity as Revealed by its Passage through Gases." The lecture will be followed by a reception.

OSCAR DANA ALLEN, whose death has been noted in SCIENCE, was born in Maine in 1836. In 1871 he was elected professor of metallurgy in the Sheffield Scientific School of Yale University. In 1874 he was also made professor of analytical chemistry. Prolonged ill health obliged him to resign these two positions in 1887, when he moved to California for four years. After that he lived at what is now called Ashford, a remote place situated at the base of Mount Ranier in Washington. There he devoted himself to horticulture, botany and biology, making the flora of the mountain near which he lived his special study.

DR. BELA LENGYEL, professor of chemistry at Budapesth, has died at the age of fifty-nine years.

DR. EDUARD SCHMITT, formerly professor of engineering in the Darmstadt Technical School, has died at the age of seventy-one years.

A SITE of about seven acres, in the District of Columbia and near Rock Creek Park, has been purchased by the Carnegie Institution of Washington to provide the necessary facilities for the office and experimental work of the Department of Terestrial Magnetism. The building to be erected is to embrace the office, laboratory and instrument shop; according to present expectations, it will be ready for occupancy early in 1914.

THE magnetic survey yacht *Carnegie* left St. Helena on April 9, bound for Bahia, and is expected to return to her home port at the end of the year, thus completing the three years' circumnavigation cruise. On the trip from Coronel, Chile, to Port Stanley, Falkland Islands, made in December and January last, she encountered an exceptionally smooth passage in rounding the Horn. However, on her run from the Falkland Islands to St. Helena, February 22 to April 3, twenty-three icebergs were sighted. The vessel is in command, as heretofore, of Mr. W. J. Peters.

THE annual report of the National Academy of Sciences shows that appropriations from the Bache fund amounting to $2,000 were made as follows:

J. A. Parkhurst, Yerkes Observatory, Williams Bay, Wis., for the determination by photographic methods of the visual and photographic magnitudes and the spectral types of faint stars, $500.

M. A. Rosanoff, Clark University, Worcester, Mass., for the determination of the several factors that influence the velocity of sugar hydrolysis, $500.

S. C. Chandler, Wellesley Hills, Mass., for the definitive discussion of the latitude variation from 1725 to the present time, $350.

F. B. Sumner, additional grant for the continuation of experiments on the effects of external conditions on growing white mice, $150.

T. A. Mann, Concord, N. H., for the determination of the cause and mode of spread of septic sore throat, $100.

S. F. Acree, Johns Hopkins University, Baltimore, Md., for the completion of the study of the action of alkyl halides on sodium phenolate, $500.

E. H. Hall, Harvard University, for the study of the electromagnetic and thermomagnetic behavior of metals, $500.

ONE of the last official acts of President Taft was the signing of a proclamation eliminating 41,150 acres from the Kansas National Forest. The tract eliminated is in the extreme western section of the forest, and includes all that part which lies west of the fifth guide meridian. It is principally a sandhill country and while it could be reforested, there is such a large proportion of alienated or privately owned land within the forest boundaries that the government's reforestation work would have to be confined to more or less isolated areas. Since the area is valuable for grazing, its restoration to the public domain was deemed advisable. At the same time that the land was eliminated from the forest it was withdrawn from entry, under the authority which congress has given the

president to withdraw land from all forms of entry except as to mineral claims for the development of metalliferous ores. The land will be restored to settlement and entry after such advertisement in the local papers as the secretary of the interior may consider necessary. The Forest Service is successfully reforesting a considerable area in the sandhills of Nebraska and Kansas, where the soil is so loose in texture that it blows away as soon as it is cultivated. Therefore, according to the government's foresters, the problem has been to grow trees in competition with the native grasses, both making rival demands on the small amount of moisture. If the grass cover is removed the soil blows out completely and exposes the roots of the trees. The success already attained indicates, in the judgment of the government foresters, that a large part of the sandhill country will become timber-producing.

THE quantity of briquetted fuel manufactured in the United States in 1912 showed a small gain over the output for 1911, and according to E. W. Parker, of the United States Geological Survey, the briquet industry may be considered as now passing out of the experimental stage and assuming a more substantial and permanent character. The quantity of briquetted fuel made in 1912, at 19 plants, was 220,064 short tons, valued at $952,261, as compared with 218,443 tons valued at $808,721 in 1911. Of these plants 7 used anthracite culm, 9 used bituminous or semibituminous slack, 1 used residue from gas manufactured from oil, 1 used mixed anthracite culm and bituminous slack, and 1 used peat. The largest producer of briquets in the United States in 1912 was the Berwind Fuel Company, of Superior, Wis., the output of which was a little in excess of 50,000 short tons. The quantity of raw material available for the manufacture of briquets, as stated by Mr. Parker, is ample and may be obtained at slight cost. The most desirable material for producing a smokeless product is anthracite culm, a plentiful supply of which still remains in the anthracite region of Pennsylvania and more is produced daily in the mining operations. It is not too much to believe or to hope that in the near future the small sizes of anthracite, such as buckwheat and smaller, that are now sold for making steam, in competition with bituminous coal and at prices below the actual cost of production, will become more valuable as a raw material for the briquet manufacturer. The output of these small sizes, produced by breaking up large coal to obtain the domestic grades—egg, stove and nut—exceeds 20,000,000 long tons annually, exclusive of 3,000,000 to 4,000,000 tons annually recovered from the culm banks by washeries. The present revenue from this product will not exceed $30,000,000. Washery and small size coal is worth from 50 cents to $1.50 a ton, the price depending on the size. As briquetted fuel it should be worth as much as stove or egg coal, or $3 to $4 per ton. The cost of briquetting is $1 to $1.25 per ton. The uniform size of the briquets makes them desirable as a domestic fuel; besides if properly made they are completely consumed and do not produce clinkers.

UNIVERSITY AND EDUCATIONAL NEWS

PRINCETON UNIVERSITY has received three gifts: $100,000 from Mr. and Mrs. Russell W. Moore, of New York City, to endow a professorship of chemistry; $125,000 given anonymously for a professorship not named, and $30,000 from Mr. John D. Cadawallader, of New York City. About $70,000 were received for current expenses.

THE decision of the jury in the case of the will of Mr. C. H. Pratt being in its favor, the Massachusetts Institute of Technology will receive the bequest, amounting to three quarters of a million dollars, to be devoted to the establishment of a Pratt School of Naval Architecture and Marine Engineering. The requirement that the money actually in hand shall be held by the trustees till it amounts to the specified sum will not cause any delay, since the estate has proved to be of such value as to lack only a few thousand dollars, and will be of the requisite amount by the time the institute is ready to use it.

WHITALL HALL, of Haverford College, which houses the scientific departments, was damaged by fire on April 8, with a loss estimated at $20,000.

THE board of trustees has approved plans for an addition to the Women's School of the Carnegie Institute of Technology.

NEW buildings of the Sorbonne, Paris, have been erected at a cost of 782,000 francs. They are the Curie laboratory, under the direction of Mme. Curie; the radium laboratory, under the direction of M. Debierne, and the Pasteur laboratory, under the direction of M. Regnaud.

PROFESSOR ALEXANDER SMITH, administrative head of the department of chemistry in Columbia University, has accepted the position of professor of chemistry on the Wyman Foundation in Princeton University, and the headship of the department of chemistry. By the desire of the authorities of Columbia University, as well as his own, he will complete three years of service with Columbia University and will accept this call to take effect at the end of the academic year 1913–14.

DR. WILLIAM TRELEASE, director of the Missouri Botanical Garden from 1889 to 1912, has accepted the position of professor of botany and head of the department of botany at the University of Illinois.

DISCUSSION AND CORRESPONDENCE

ON METHODS OF TEACHING MODERN LANGUAGES

THE basis and warrant of all language teaching must be psychological. But among all the multitudinous articles and books on the subject, there are only a very few which take cognizance of the psychology of language teaching, although, to be sure, the practical application of the principles is practised in part, consciously or unconsciously.

The test of any method must be psychological. Here mere practical results can not be the criterion. The question should not be: Has the learner acquired so and so much of a vocabulary? but rather it should be: Has the learner been acquiring good *mental habits* while he has been acquiring the vocabulary? That is to say, the method must be based upon sound laws of the mind, to follow which means to produce good *habits of study*.

1. The newer school of linguists are agreed that language is an activity of the mind; not a thing thrust upon the individual, but rather the outward manifestation of mental states. Speech without ideas is useless. Adults do not naturally learn words for the sake of learning them, but only for the purpose of expressing ideas. We find in normal adults first the idea, then the expression of it, or possibly the two simultaneously, but not the reverse.

2. Physiological psychology teaches us that four distinct centers of the brain are active in the acquisition of language; namely: the auditory, the visual, the motor writing, and the motor speech centers, the first two sensory, the latter two motor.[1] The function of the auditory center is to receive sensory impressions through the nerves of the ear; that of the visual center to receive impressions from the nerves of the eye; the motor-writing center controls the muscles of the hand in writing, while the motor speech center controls the muscles of the speech organs.

It has been established, also, by experimentation that the strength of the sensory impressions upon these centers varies with different individuals. There are those who get stronger impressions by the auditory than by the visual center, and more facile expression by the motor-speech than by the motor-writing center, and *vice versa*.

Moreover, there are in the case of the four brain centers under discussion not only nerve currents from the end-organs to the centers and from the motor centers to the muscles, there are also the association areas of the brain which serve communication between these centers, thereby bringing about a lively interaction between them.

3. Without going into the old question whether sensation is the sole principle of knowledge, we are on safe ground psycholog-

[1] Cf. Wundt, Wilhelm, "Principles of Physiological Psychology," English translation, London and New York, 1904, pp. 302 ff.; Judd, C. H., "Psychology, General Introduction," New York, 1907, pp. 51 ff.

ically when we assert that in learning a language auditory, visual and kinesthetic sensations play the most important rôle, and are in fact the basis of knowledge. It follows then that the greater the number of sensory impressions that can be enlisted in the acquisition of language, the greater the acquisition. It follows also that the more combined the activity of the senses, the more rapid and the more thorough will be the organization of the speech centers physically and psychically.

4. From perceiving sensations, that is, from percepts, the mind proceeds, by discriminating, comparing, judging from knowns to unknowns, to form concepts.

5. Retentivity depends for its strength upon the strength of the original impression and upon the frequency of repetition. It shows greatest virility in the retention of linguistic forms when the four speech centers operate to heighten the intensity of the impression.

6. Beyond this there is the ideal of persistence which is strengthened by resolutely overcoming obstacles, *e. g.*, by mastering assigned tasks of difficulty sufficient to form a real obstacle to their consummation.

What do these facts mean to the teacher of language, and how should pedagogy make use of them?

1. It is unnatural and hence poor pedagogy to teach isolated words, and to proceed from the parts to the whole; that is, here, from the isolated vocables to the sentence, the judgment. The reverse: from a consideration of the whole sentence to a consideration of the parts is the law of nature, and is a good psychological principle.

Thus the argument which is often used against the analytical or direct method that adults do not learn language like children do loses much of its force. Certain it is that for adults the idea comes before the sign for the idea, although, to be sure, the mature mind, accustomed to abstract thinking, soon demands that it be given not only the percepts but the concepts, and the general concepts as well.

2. Good pedagogy should call into activity all the powers of the mind of the learner. Thus in the case of the language teacher, to utilize the visual and the graphic centers only, and allow the auditory and the motor speech centers to lie barren, is to get only a portion of the sensory impression that may be got if all the centers are utilized.

Again, since some individuals of a group will learn better by the utilization of the visual and the graphic centers, others by the utilization of the auditory and the motor-speech centers, etc., every course in language should give opportunity for both forms of impressions and both forms of expression, *i. e.*, for hearing, and seeing (reading); for speaking and writing.[3]

3. Language study is best cultivated by utilizing the nervous energy of all four centers, that is, the ear, the eye, the vocal organs and the hand. Each must support the other, thus heightening the total impression.

4. Generalizations, in this case principles and laws, must base upon sense perceptions, in this case spoken or written words and phrases, and must follow, not precede them. Ample opportunity is demanded to discriminate between various cases, genders, numbers, persons, tenses, modes, etc.; also between the various shades of meaning in words, and various modes of expression with slightly varying significance; also opportunity to make combinations as in reasoning from known roots to the various compounds of such roots, etc.; also opportunity for comparisons as in comparing the idioms of the foreign tongue with the mother tongue, as *e. g.*, in translating.

5. Retentivity depends upon the strength of the impression received in the class room. Aural impressions are heightened by visual, graphic and oral impressions. Since retentivity depends upon the frequency of the im-

[3] It has been claimed that Americans are visualizers, and from this it has been argued that the reading method is the best for Americans. But it is a patent fact among psychologists that the combined action of the four speech centers is stronger than that of any one of them, and thus this argument falls flat. Moreover, the visualizer, above all others, needs to have his auditory and other centers developed.

pressions, language material must be worked over repeatedly in various ways, thereby insuring permanence of the impressions. The natural association of name and object must be made use of. That is, the learner shall not be taught to think from the foreign symbol to the symbol of the mother tongue, and from that to the object, but he shall be taught to think in the foreign language from the thing to the name and *vice versa,* just as he does in the mother tongue.

6. The ideal of persistence must be enforced by accomplishing set tasks, tasks sufficiently difficult, and including not merely memory work but reasoning as well, as, for instance, translation and "free composition," in which he compares and discriminates, chooses and rejects.

The imagination, the esthetic and the moral feelings must be fed by reading literature of high moral and esthetic standard, and by laying emphasis on the qualities which are to be inculcated.

Charles Hart Handschin

ACADEMIC FREEDOM

To the Editor of Science: In the current issue of Science is a letter on the subject of academic freedom, in which is given a quotation from an address delivered some years ago by President Schurman. Your correspondent regards the statements in the address as highly commendable, but it seems to me that the address contains within itself the "enzym" of its decomposition.

Academic freedom is like friendship "but a name that lures the soul to sleep." Freedom of teaching is permitted only so long as no serious attack is made on widely received opinions. As the "Professor" says, in Mallock's "New Paul and Virginia," "Opinions can only be tolerated when they lead to no possible consequences." Let us suppose, for instance, that when Professor Schurman's address was published, a subordinate instructor in the university had spoken as follows: "When President Schurman speaks of 'God's truth' he speaks of something about which he knows no more than a gibbering idiot in the nearest asylum. God, if he exists, has apparently not declared himself to anybody. All such allusions are either mere catering to popular superstitions, or are on the same plane as the beliefs of the lowest savages." How long would this instructor retain his place in the university? I would be pleased to hear what your correspondent would advocate concerning a person who should so express himself. A hundred other examples can be selected. What would become of a subordinate instructor who should at a Washington's birthday address say that Washington was a traitor and should have been hanged by the British, if they had caught him.

Henry Leffmann

When the necessity of freedom for university teachers and investigators is emphasized, it is never assumed that this freedom carries with it a license to do or say anything and everything. University teachers do not claim that they constitute a class with special privileges. But as a body of men with serious and important work to do, they claim the freedom that is necessary to enable them to perform this work and to fulfill their obligations to society. Freedom in this field, as everywhere, is a reasonable freedom, involving law, responsibility and due regard for others. Academic freedom has its roots and its justification in the duty which the teacher owes to his students and to the community. It may well be that at times it is just as important to emphasize this duty and responsibility as to call attention to the necessity of freedom. But one side is the counterpart and complement of the other: where there is no freedom there can be no responsibility, and where there is no feeling of responsibility there can be no genuine freedom. If this is true, it would seem to follow that the limits of a reasonable freedom can not be fixed by any abstract definition. What are the reasonable limits in any particular case must be decided by the whole set of circumstances, as judged by reasonable men living in a reason-

able society. Of course this involves a circle; but there is no way of escaping it.

J. E. Creighton

SCIENTIFIC BOOKS

An Introduction to the Study of the Protozoa. With Special Reference to the Parasitic Forms. By E. A. Minchin, Ph.D., F.R.S., Professor of Protozoology in the University of London. London, Edward Arnold; New York, Longmans, Green & Co. Pp. x + 517. Price $6.00 net.

When an "Introduction" to the study of a special group covers over 500 pages of which perhaps a third are in fine print, a reader might infer that the main text would require a lifetime to prepare and digest. Of the many students of the group described in this book not a few have given an entire lifetime and others are now devoting all of their energies to the main text. Amongst these Professor Minchin is one of the most conspicuous and best informed. We think, however, that he is a trifle too modest in calling this splendid presentation of a difficult field an "Introduction," for the great variety of subjects discussed, the judicial attitude assumed, and the wealth of references used, are more characteristic of a treatise than of a primer.

Like the majority of general works on Protozoa, this one consists of two main sections, one devoted to general problems, the other to special groups. Such treatment involves more or less repetition and requires many cross references, but is most useful in picturing the nature and extent of problems in general biology, as illustrated by the Protozoa. In the general section four chapters are devoted to the distinctive characters, modes of life, general physiology and reproduction; five chapters to the general organization and life cycles, and one chapter to fertilization and sexual phenomena of the Protozoa. In the more special part, one chapter is given to the Sarcodina, two to the Mastigophora, three to the Sporozoa and one to the Infusoria, while a concluding chapter deals with the general phylogeny of the Protozoa and with two doubtful groups, the Spirochætida and the Chlamydozoa. The sub-title of the book disarms criticism of the disproportionate treatment of the four special groups, the Infusoria receiving the least attention, but such treatment may go a long way in overcoming the too-common generalization that ciliates are *the* Protozoa, and may help to a broader comprehension of the biological value of representatives of the other and larger groups of unicellular animals.

The problem of karyokinesis, especially the evolution from simple to complex mitotic structures, is well treated; a more critical discussion of the so-called chromosomes in Protozoa and the evolution of chromosomes would have been a welcome addition, since there is the greatest confusion at the present time over this apparently simple matter. The terms "chromatinic" and "achromatinic" are used in place of chromatic and achromatic, the change being adopted on the ground that the latter terms have a distinctly different meaning in optics. We agree that the change is desirable, but there is little probability that it will have a wide following, since these terms are firmly grounded in modern biology. Another new term—"chromidiosome" for the smallest unit of chromatin inside or outside of the nucleus, is most useful so also is the word "endosome" for the German term "Binnenkörper."

Minchin makes a distinction between Protozoa of "cellular" grade and those of "bacterial" grade, but the effort seems to be somewhat obscure and does not help much in defining the Protozoa, having a perplexing rather than a simplifying effect. The bacterial nucleus is sometimes a single karyosome which might be compared with a typical nucleus; more often there is no morphological nucleus, but chromatin granules are scattered about the entire organism. It is presumably this type of bacterial structure that Minchin refers to in Protozoa of bacterial grade, and if so the Spirochætes might well fall within such a group; but these are treated separately as a doubtful group. On the other hand, some well-defined Protozoa, such as *Dileptus gigas*, for example, have similar scattered chromatin

masses, but could scarcely be considered of bacterial grade. Certainly all undoubted Protozoa are of the cellular grade and are characterized by nuclei more or less different from typical nuclei of tissue cells.

The discussion on syngamy and sex, although slightly halting in argument, is admirably presented. Minchin apparently favors the rejuvenescence theory, but finds a logical difficulty in the phenomena of parthenogenesis and autogamy and has apparently overlooked some recent work on variations as an outcome of amphimixis, as well as works recording failures to rejuvenate after conjugation in cultures. This general problem, however, has been so recently re-opened that the literature may not have reached him in time to be incorporated.

In dealing with the flagellates, especially the blood-dwelling forms, Minchin is perfectly at home and speaks with a first-hand knowledge that carries conviction. The life histories of the Trypanosomes and other hæmoflagellates are given with a firm touch and many of the facts are from his own hitherto unpublished results.

In the section on general physiology the usual physiological activities are concisely, but well, treated. The matters of degeneration, regeneration, and the phenomena of decreasing vitality in Protozoa are somewhat disappointing in the mode of treatment; so also is the neglect, throughout the volume, of evidence derived from the study of various types of Protozoa by the bacteriological culture methods, which for certain groups of the Protozoa, notably the Amœbæ, promise to throw a flood of light on the vexed question of pathogenic species. It is most uncharitable, however, to cavil over these minute defects, if indeed they are defects, when the vast and rapidly growing literature on the Protozoa is so admirably welded together in a readable whole, and we shall have occasion many times repeated, to thank the author for his labor, his critical insight, and for the judicious care with which he has selected the material embodied in this volume.

Gary N. Calkins

Food in Health and Disease. By Nathan S. Davis, Jr., A.M., M.D. P. Blakiston's Son & Co. 1912. Second edition. Pp. 449.

It is fair to assume from a statement in the preface that the author expects this work to be used in the instruction of physicians and nurses. It would seem desirable that any publication to be used in this way for instruction in the principles of nutrition should present the latest and most reliable knowledge. This volume fails to meet this requirement. Not only does it contain many statements which must be regarded as erroneous, but some of the most important advances in our knowledge of food chemistry and metabolism receive no consideration.

One looks in vain, for instance, for a discussion of the recent additions to our knowledge of the efficiency of individual proteins for constructive and maintenance purposes. Osborne and Mendel have shown that the alcohol-soluble protein of maize, when it is the only protein fed and is supplemented by the other classes of nutrients in efficient forms, does not serve to maintain life, much less build tissue. Marked differences are observed in the efficiency of other proteins. Without question, the influence of certain food substances upon the secretion of the digestive fluids should also receive extended attention in a study of dietetics. It would seem that whoever is to assume the direction of the diet of the well and the sick should have some inkling of this most important new knowledge.

It is easier to be charitable toward omissions of this kind, however, than towards inaccuracies and looseness of statement. It is fair to inquire what justification there is for the statement that carbon dioxide "aids digestion by promoting chemical changes and muscular activity." The statements that "tissue waste is most rapid under a protein diet," "that nitrogenous food in greater quantities than are strictly needed to maintain nitrogen equilibrium will cause a waste of tissues as well as repair," and "in other words, all changes are stimulated by proteins," are most surprising. It is true that the body tends to

adjust its protein catabolism to the protein supply and that a sudden increase of protein in food causes a quite immediate increase in protein cleavage. This does not mean, however, that an excess of protein causes tissue waste because this increase in protein catabolism, due to an increased protein supply, undoubtedly occurs at the expense of nitrogen compounds that are still in a circulatory or labile condition.

There can be no disputing the fact that "animal food requires a considerable quantity of oxygen for its utilization"! It is well established, to be sure, that the amount of heat liberated by the use in the body of a given volume of oxygen is somewhat less for proteins than for carbohydrates. In view of the facts that oxygen consumption is practically proportional to the amount of energy developed and that all the nutrients require for their oxidation in the body "a considerable quantity of oxygen," the above statement seems to be somewhat peculiar in form, to say the least.

We are not told on what experimental evidence it is asserted that proteins are required for the production of nervous energy, nor is the difference between nervous energy or any other energy explained.

To make the terms "fibrinogen" and "casein" synonymous as the principal protein in milk is hardly excusable. Fibrinogen is a term given to the mother substance of fibrin. It is possible that the author had in mind caseinogen, a name once proposed for the casein of milk before coagulation.

Starch, cereals and vegetables, when cooked imperfectly, are characterized as "indigestible" and we are told that a "vegetable protein is very imperfectly digested and absorbed." In the first instance, the term indigestible may be used in the popular sense, difficult of digestion, for the author, in several places, confuses the meaning of the terms digestion and digestibility, but to state that a vegetable protein is very imperfectly digested and absorbed is, as a general statement, in utter defiance of facts. The records of digestion experiments with human foods show that on the average between 80 and 90 per cent. of the protein of cereals, vegetables and fruit is digested and absorbed. Vegetable proteins, according to this author, "are mostly globulins." The proteins of wheat flour, of which we consume more perhaps than any other vegetable forms, consist chiefly of glutenin and gliadin, neither of which is globulin. It does not appear to be true that globulins predominate in other cereals. Legumin is made to resemble casein "in many of its chemical reactions." We now know that the legumins are globulins and they appear to have little similarity to the principal protein of milk. The theory that by churning "the albuminous envelopes of the fat globules of the cream are broken and the fat particles are permitted to commingle and form a solid mass" was abandoned long ago. Those who are making a study of milk advance the theory that by adsorption the fat globules cause a concentration of albuminous matter around them, but the breaking of the envelope through the agitation of the cream is now not accepted. The statement that sodium chloride acts in the blood as a solvent of the globulins would seem to be somewhat precarious.

In discussing cow's milk, the author informs us that "after the first week, it is usually the richest and remains about the same for months, provided the animal's diet is uniform." The fact is, as shown by numerous analyses of the milk of cows through the entire period of lactation, the milk is the least rich a few weeks after parturition and increases in richness as the period of lactation progresses, especially when there is a decrease in the yield. It seems to be assumed that a change in diet changes the composition of the milk which, in the main, is contrary to the results of extended observations.

When the author enters the field of practical dietetics, he still seems to be subject to error. In dealing with the influence of the diet upon the mother's milk, he gives a set of rules which, in the light of recent observations, should be lightly regarded. For instance, we are told that to increase the total quantity of milk and to decrease the total solids, there should be an increase in the proportion of

liquids in the diet. Such investigations as have been made do not bear out this statement. Nuts are said to be of little value as food, but their composition and digestibility show them to be highly nutritious. Fish is classed as "an economical kind of protein food." This may be true of certain species, especially when salted or smoked, but some species when bought in the fresh condition, as for instance blue fish, furnish a very expensive diet, much more so than even the expensive meats.

Gravity cream is said to contain 16 per cent. of fat. If the term "gravity" is used in the usual sense as applied to cream raised by deep setting and pan setting, then under some conditions it would contain double that percentage of fat and even more. Cream does not have a uniform composition, but varies greatly according to conditions.

It is hardly necessary to multiply these references. There is running through the first part of the volume, which relates to the general principles of nutrition, a general tendency to inaccuracy and indefiniteness of statement. For the purposes of instruction, the language might wisely be condensed and reference to unimportant details omitted.

No discussion is attempted in this connection of the author's recommendations as to the diet for invalids and for persons in health under various conditions because he states that the recommendations "are largely based upon my own observation" and such observations constitute original data. No intelligent discussion is possible unless the extent and character of these data are understood.

W. H. JORDAN

NEW YORK AGRICULTURAL
EXPERIMENT STATION

Home University Library of Modern Knowledge. Edited by HERBERT FISHER, GILBERT MURRAY, J. ARTHUR THOMSON and WILLIAM T. BREWSTER. New York, Henry Holt & Company.

The Cambridge Manuals of Science and Literature. Edited by P. GILES and A. C. SEWARD. New York, G. P. Putnam's Sons.

An anecdote which greatly impressed my boyish imagination some thirty-five years ago related to certain little scientific primers in terra-cotta colored cloth, written by such men as Huxley, Tyndall and Lubbock, and published, I think at a shilling, by Macmillan. The story was that some one had remonstrated with Macmillan for getting such eminent men to prepare these simple little works, when "any schoolmaster could have written them." The publisher replied that his experience had shown him that it took just such men to write good primers; that it was one of the most difficult things to accurately and effectively present the gist of any scientific subject, and attempts to have such work done cheaply by inferior men had always given more or less unsatisfactory results. Since that time multitudes of elementary scientific works have appeared, and the opinions attributed in the story to Macmillan have not been shared by all their publishers. We could hardly say, at the present time, that excellent works may not be written by men of small scientific reputation; but it assuredly remains true that they must be written by men of good training and ability. The abounding faults of our current text-books bear witness to the reprehensible lightness of heart and mind with which, in a commercial age, the teaching profession attempts to gain money and reputation.

The two series of volumes now before us, issued from New York, but prepared and originally published in England, represent new attempts to carry out the Macmillan plan. Essentially products of the universities, they are part of the general scheme of "university extension" which now finds so much favor. Varying greatly in literary and perhaps scientific merit, they maintain on the whole a high standard; and in nearly every case it may be said that the author is an eminent representative of the branch of science he discusses. The field covered is so large that no reviewer can critically consider more than a small minority of the volumes, yet in a sense he can judge best the ones on unfamiliar sub-

jects, testing by his own experience their power to interest and instruct. Tried in this way, I have found many of these little books quite inspiring, and have learned much from them.

The Home University Library volumes are larger and more pretentious, averaging about 250 pages, but selling at the very moderate price of 56 cents, post free. The Cambridge Manuals, with about 150 pages, sell for 40 cents net. The general appearance of the Home University volumes is very good, but I do not like the "rose-colored art cloth" of the Cambridge books, while the cover design, reproduced from a wood-cut of the year 1581, is ugly if historically interesting. The Cambridge Manuals usually deal with more specific or limited topics than the other books, and consequently are often more detailed or concrete. From the standpoint of a student this seems to be an advantage. The volumes are too numerous to be separately reviewed in detail, but a few notes on some of them may be useful.

Home University Library

Matter and Energy. By F. SODDY.

Very interesting and useful to one who is not a physicist. It is worth while to quote a few stimulating paragraphs:

> Our most fundamental conceptions are, like ourselves, material. The elaboration of them is easy, but their simplification to suit the immaterial world, whither we now wish to embark, is difficult almost to impossibility. If our minds habitually thought in terms of electricity and magnetism instead of in terms of matter and motion, what a world would be opened up! (p. 165).

> Modern science, however, and its synonym, modern civilization, create nothing, except knowledge. After a hand-to-mouth period of existence, it has come in for and has learned how to *spend* an inheritance it can never hope to restore. The utmost it can aspire to do is to become the Chancellor of Nature's Exchequer, and to control for its own ends the immense reserves of energy which are at present in keeping for great cosmical schemes (p. 247).

We may not be inclined to take all this quite literally; thus, civilization is not really synonymous with science, even in its modern developments; but it is all very interesting and productive of thought.

The Making of the Earth. By J. W. GREGORY.

Parts of this seem rather uncritically written. We are astonished to read (p. 127) "the evidence, therefore, of the distribution of animals and plants proves the former existence of continents that have been dismembered and of land routes that have foundered beneath the oceans"; and there is actually a full-page map showing the distribution of the Acræidæ, a tropical family of butterflies, as part of the important evidence of land routes across the present oceans! On p. 244 it is stated that the first traces of vertebrates are Silurian, whereas it is generally considered that America yields Ordovician fish remains.

Anthropology. By R. R. MARETT.

Written in a breezy style, with due regard to the idea that "the 'dry bones' of history, its statistical averages, and so on, are all very well in their way; but they correspond to the superficial truth that history repeats itself, rather than to the deeper truth that history is an evolution. Anthropology, then, should not disdain what might be termed the method of the historical novel. To study the plot without studying the characters will never make sense of the drama of human life" (p. 242). On p. 40 it is implied that the antiquity of the Calaveras skull is still a matter of opinion. Here and there, the flow of rhetoric appears to lead to some looseness of statement, as when it is said that Wallace discovered the law of natural selection "at the same moment" as Darwin, instead of independently, as it should have been.

Man. A History of the Human Body. By ARTHUR KEITH.

Very interesting, with a good deal of information which will be new to the average biologist; some of it in fact based on new work by the author. We may perhaps object to the account (p. 171) of *Pithecanthropus* as "the fossil man of Java," without any expression of doubt regarding its humanity.

On p. 237 bacteria are called "fauna." Comparing the very different styles of the books on Anthropology and Man, I think it must be admitted that that of the latter is preferable.

A few others of special interest must be mentioned:

Psychology. By William McDougall.

The Principles of Physiology. By John Gray McKendrick.

Electricity. By Gisbert Kapp.

The Cambridge Manuals

Links with the Past in the Plant World. By A. C. Seward.

An admirable introduction to paleobotany, by one of the greatest authorities on that subject. As a frontispiece we have a picture of *Sequoia magnifica* in the Yellowstone National Park. A particular merit of this book is its treatment of living and extinct plants together, showing how they throw light on one another; it is especially to be commended to those botanists who think themselves excused from any consideration of fossils.

Primitive Animals. By Geoffrey Smith.

A most instructive treatment of the primitive members of various phyla. Used as a text-book, it might be made the basis of a very interesting introductory course in zoology. On p. 41, the account of the distribution of *Peripatus* is incomplete, and inaccurate in the statement that the animals do not occur in the northern hemisphere. It is also no longer permissible to speak of "a small number of closely related species," in view of such works as Bouvier's Monograph. The classification of animals at the end of the book is modernized, but the "Myriapoda" are left to include both centipedes and millipedes.

The Individual in the Animal Kingdom. By Julian S. Huxley.

An essay in zoological philosophy, or philosophical zoology, influenced, as stated in the preface, by Bergson. Well-known facts are brought forward to show how difficult it is to define an "individual," and it is finally concluded that individuality is a tendency which may be manifested in varying degrees. Consequently the author makes the term cover cases in which he sees this tendency, although most of us, simply as a matter of nomenclature, will hesitate to follow him.

> The communities of ants and bees are undoubted individuals. . . . When we come to man, this power possessed by one unit of entering into more than one individual "at once" becomes very marked. A man can very well be at one time a member of a family, a race, a club, a nation, a literary society, a church and an empire. . . . It yet remains true that the state or society at large is still a very low type of individual: the wastage and friction of its working are only too prominently before our eyes (pp. 142–143).

Earthworms and their Allies. By Frank E. Beddard.

This deals principally with the geographical distribution of earthworms, but also contains a good account of their structure. The author is of course a well-known authority both on earthworms and distribution in general. I found the work very interesting, but I fear many will be repelled by the multitude of names of genera and species.

Prehistoric Man. By W. L. H. Duckworth.

An up-to-date account of what is known about early man—yet of course not *quite* up to date, as it was printed before the recent discovery in Sussex. So far as I can judge, it seems to be admirably done, and one is really astonished at the mass of information gathered in recent years. All the really important contributions have been from the old world, and "it is important to notice that time after time the attempts made to demonstrate the early origin of Man in the American continent have resulted in failure, which in some instances has been regrettably ignominious" (p. 55).

Other interesting volumes are:

Spiders. By Cecil Warburton.

Life in the Sea. By James Johnstone.

House Flies, and how they Spread Disease. By C. G. Hewitt.

The Migration of Birds. By T. A. Coward.

The Work of Rain and Rivers. By T. G. Bonney.

The Natural History of Clay. By ALFRED B. SEARLE.

The Origin of Earthquakes. By CHARLES DAVISON.

Rocks and their Origins. By GRENVILLE A. J. COLE.

The Modern Locomotive. By C. EDGAR ALLEN.

Considering that high general level of excellence, together with the very moderate prices, it would seem that almost any public library or large high school would do well to obtain both series. The treatment, usually different from that of the conventional text-book, is likely to interest many readers, some in one subject, some in another. There is not as much duplication in the two series as some of the titles might suggest; thus "Anthropology" and "Man" in the one do not at all take the place of "Prehistoric Man" in the other.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO

On the Foundation and Technic of Arithmetic. By GEORGE BRUCE HALSTED. Chicago, The Open Court Publishing Company. 1912. Pp. 133.

The main purpose of this book is to place the number concept of modern mathematics within easy reach of the teacher in the grades. That there is reason for the existence of such a text is apparent from the fact that people in general and to some extent even teachers of arithmetic still look upon mathematics as "the science of quantity." The primitive number concept of modern mathematics has nothing to do with quantity. Mathematical research on this subject has been slow in commanding the attention of non-mathematicians. It is not very many years ago that a prominent American psychologist published a book in which the simple act of "counting" was declared to be an act of "measuring." It is not very long since, that a series of arithmetics was published in which the primitive idea of number was presented as being that of "ratio." Dr. Halsted brings out clearly and strongly the fact that primitive number, whether considered from the standpoint of its modern logical exposition, or from its historic development, is wholly divorced from measurement, and that number viewed as a ratio presupposes counting and is a more involved concept. The book under review contains an able presentation of fundamental concepts. This every one familiar with Dr. Halsted's earlier works had reason to expect.

The leading topics discussed in the book are as follows: The genesis of number, counting, genesis of our number notation, addition, multiplication, subtraction, division, decimals, fractions, measurement, mensuration, order, ordered sets, ordinal number, the psychology of reading a number, arithmetic as a formal calculus, suggestions on the teaching of arithmetic.

Halsted makes the interesting observation that, besides the "ordinal number" and "cardinal number," modern civilization has introduced "nominal number" used as a proper noun, as in the telephone service. "Since the size of the number and its place in the number series are here alike irrelevant, the whole stress falls upon its recognition as a unique name."

The text contains numerous historical statements, some of which are open to criticism as not embodying the latest researches. Moreover, there is a frequent lack of bibliographical reference to authorities. Thus Halsted gives $\pi = 3.14+$ and $\pi = 3.1416-$ and then adds:

> This is historically the first meaning of the signs + and —, which arose from the marks chalked on chests of goods in German warehouses, to denote excess or defect from some standard weight.

In view of the fact that historians have been in doubt as to the exact origin of + and —, the authority for Halsted's categorical statement would be interesting. Cantor[1] and Tropfke[2] both express themselves with great reserve on the validity of the explanation endorsed by Halsted. Eneström in a later re-

[1] Cantor, "Geschichte der Mathematik," Vol. II. (2), 1900, pp. 230, 231, 320.

[2] J. Tropfke, "Geschichte der Elementar-Mathematik," Vol. I., 1902, p. 134.

search arrives at more positive results, indicating a different origin for +. He shows that in Widman's printed arithmetic of 1489, + had not yet become a purely mathematical sign, that with Widman + meant simply "und" (and), in conformity with a practise of the middle ages, according to which a symbol closely resembling + was used for "et."[3] It is now known that Widman possessed a manuscript algebra in which + is used for "et," even in cases where "et" does not mean addition.[4] Widman in 1849 sometimes indicated subtraction by the special symbol —, a usage found somewhat earlier in a Dresden manuscript of the year 1481.

Halsted attributes decimal fractions to Stevin (1585), but makes no mention of the earlier use of decimals by Vieta[5] (1579) and Rudolff[6] (1530). Halsted mentions Napier (1617) as the first to use the decimal point, but the period (or the comma) was used by Bürgi as early as 1592,[7] by Prätorius in 1599[8] and by Kepler in 1616.

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Colorado Springs

Treatise on Light. By Christiaan Huygens. Rendered into English by Silvanus P. Thompson. London, Macmillan & Company. 1912. Pp. vii + 128.

Ever since its birth, in 1690, the wave theory of light has been adapting itself to environment. Just at the present moment, when the completeness and perhaps the competency of the wave theory is being called in question by certain phenomena of radiation and radioactivity,[1] an English translation of Huygens's great "Treatise on Light" is particularly opportune. The fact that this translation has been made by Professor Silvanus P. Thompson is an ample guarantee that it has been done in a scholarly and sympathetic manner. Two distinct courses are open to one who wishes to transfer into English the thought of a foreign author who lived more than two hundred years ago—either he may employ the English phraseology of our own day, or he may use that which he conceives to have been the current diction of the period in which the work was composed. In either case he must avoid anachronisms, and in either case the problem is difficult. So many modes of expression are common to the languages of western civilization and so many of these forms have disappeared from our language during the last two hundred years, that a certain quaintness is inevitably given to any translation of old French, German, or Italian, in which particular pains is not taken to avoid these obsolete phrases. It is the second of these alternatives which Professor Thompson has chosen. The result is that the volume including its title page, table of contents, text, paper, binding, typography, size, and English style, is as nearly as possible what it would have been if Huygens had lived and worked and published on the other side of the English Channel. This is not to be understood as meaning that the translation is in any sense a literal one, for it is precisely the spirit of the work which Professor Thompson has caught and has faithfully reproduced. In brief the volume is in every way worthy of the great contributions to science which it contains. The first three chapters in which Huygens's principle is enunciated had already been made available to English readers through *Harper's Scientific Memoirs.* But the full evidence for Huygens's principle can only be obtained by understanding Chapters 4, 5 and 6. Atmospheric refraction is explained in Chapter 4 practically as we have it to-day. In Chapter 5 the wave sur-

[3] *Bibliotheca mathematica,* 3 F., Bd. 9, 1908–09, pp. 155–157, 248.

[4] *Bibliotheca mathematica,* 3 F., Bd. 10, 1909–10, p. 182, 183.

[5] *Bibliotheca mathematica,* 3 F., Bd. 11, 1911, p. 340.

[6] *Bibliotheca mathematica,* 3 F., Bd. 10, 1909–10, p. 243.

[7] *Teachers College Bulletin,* 1910–11, No. 5, p. 19.

[8] Cantor, *op. cit.,* Vol. II. (2), 1900, p. 619.

[1] W. H. Bragg, evening discourse before the British Association at Dundee, *Nature,* 90: 559 (1913); R. A. Millikan, vice-presidential address before the American Association for the Advancement of Science, *Science,* January, 1913.

face is worked out for Iceland spar. Here it is shown how a ray may fall obliquely upon a plane surface without suffering refraction. Here too is set forth the invention of the ellipsoidal wave surface to explain refraction in uniaxial crystals—one of the cleverest chapters in the entire history of science. The sixth chapter is given over to "the figures of transparent bodies which serve for refraction and for reflection." Here the principle of "equivalent optical paths" is employed with its well-known elegance. The thanks of all students of optics are due to both translator and publisher for this complete and accurate rendition of a memoir which has long been so rare and expensive as to be practically out of reach of the ordinary reader.

H. C.

SPECIAL ARTICLES

THE HISTORY OF LOST RIVER

In a previous paper written over a year ago and published by the Society for Protection of New Hampshire Forests, in their annual report for 1911, I tried to solve the problem which Lost River presents. Since that time I have made several visits to Kinsman Notch and have each time found new evidence on which to base conclusions. The following paper is offered as a further attempt at an explanation, based on the new evidence.

Lost River is a small stream rising in Kinsman Notch, about seven miles in a westerly direction from North Woodstock, New Hampshire.

The spectacle which presents itself on entering the river is very confusing. The river is immediately lost to view among a mass of huge granite blocks, some of them as large as average dwelling houses. Large potholes are numerous, as well as many beautifully curved water channels. Many of the potholes are fractured and fragments of these lie in the general mass. By careful inspection it is seen that this is an old rock gorge, and that something violent has taken place. Many joint blocks have fallen in, making it impossible to follow the water of the river in its course without ladders and bridges. The Society for Protection of New Hampshire Forests, has purchased 148 acres, including the Lost River and the overhanging cliff, and has placed ladders and bridges in the gorge, so it is no longer difficult to see all the interesting points. There are two sets of caverns (so called because of large vacant spaces between the joint blocks), an upper and a lower. The upper caverns are about one quarter of a mile long. The stream emerges from these at Paradise Falls, flows unobstructed for about 150 feet, and plunges again beneath another mass of joint blocks, the lower caverns. The latter are not so imposing nor as extensive, although very interesting.

In contemplating this heap of granite blocks with the purpose of finding an explanation to the riddle, there are three agents which present themselves as seemingly capable of bringing about such confusion: frost action on a large scale; the disruptive force of a moving glacier; and earthquake action.

There has been considerable frost action in the gorge, and without doubt many blocks have been slowly wedged apart and fallen down from the sides of the gorge. That frost action, however, does not account for all the falling and movement, is to me quite evident. When in the lowest caverns one finds cases where blocks which have slipped from between other huge blocks in place, have left the upper and lower blocks entirely unmoved in the solid ledge. Smooth slickenside-like patches give evidence of a rapid and violent movement. This does not resemble frost action. The fearful confusion and pell-mell attitude of the mass also bespeak something more than the gradual work of frost.

The disruptive force of a moving glacier would seem at first glance capable of creating such a confused mass of joint blocks. It could not account, however, for the movements below the solid ledge, as described above. In one case I found a movement in a lateral direction between two blocks. The lower one is evidently in place and a part of the solid ledge, and the upper one has moved against the direction of movement of the ice about four inches. If ice were accountable for the slip,

surely the lower block could not have been moved, and the upper block would not have moved contrary to the ice motion. If the slipping can be explained by frost action, the positions of the other blocks can not, for they have evidently been thrown about by some other force. Furthermore if moving ice caused the confusion, one would naturally expect to find several different kinds of rock in the gorge. As far as I have explored the river one kind of rock only is present, a rather coarse biotite granite. A dark schist occurs in Beaver Meadows and some fragments of this should be found in Lost River only half a mile away. In the true moraines 100 yards away to the south, abundant fragments of this schist are found, but nothing of the kind in Lost River.

The fact that many of the potholes are cracked, disrupted and weathered as deeply as rocks outside of the gorge makes it evident that most of the potholes were formed before the main force which caused the confusion came. In any event most of the potholes were formed when the river had much more sediment than at present, and presumably this was during Glacial Period times, or at least when the ice had not retreated wholly from Kinsman Notch. The present amount of flow of very clear water is too small to account for the larger potholes. The largest of all is about twenty-five feet in diameter, narrowing toward the top. It has been badly broken and about one half only remains in position.

From the extraordinary positions of some of the water-worn channels it seems possible that much of the water work was done subglacially, although there is no proof as yet that such was the case. The main movement of the great ice sheet was south about 6° west, while Kinsman Notch at Lost River runs nearly east and west. It is probable that the ice in Lost River was nearly stationary during the height of glaciation, and that the main body passed over it with a shearing motion toward the south. The drainage under the ice would follow the present natural slope.

A study of the ground between Lost River and the cliff to the north helps to an understanding of what has probably taken place in the river. The way is difficult and somewhat dangerous. Huge blocks of granite are met with at once. They are piled in a pell-mell manner. As one ascends the blocks become somewhat smaller. There has undoubtedly been a large rock fall and one which immediately suggests a heavy earth shock as the starting force. Gradual weathering and falling would not account for the manner in which the rocks are wedged together. Weathering on all the large blocks of the rock fall, and on those in the river, has gone, as far as I can judge, to the same extent. From this fact it is also natural to conclude that the fall was of a sudden nature and not gradual. If the blocks had fallen one by one, weathering should have progressed to very different extents in different blocks. The granite of the cliff and that in Lost River is the same. There are no traces of any rock but the local granite in the rock fall, so this immediately does away with any ideas of a lateral moraine. It is very evident from the amount of weathering that this rock fall came long ago, and probably soon after the ice of the Glacial Period had retreated from Kinsman Notch.

It is now plain that most of the blocks in the river came from the sides of the original gorge, and not from the cliff, as I had formerly thought. Veins and dikes from the solid walls of the gorge can be found frequently in the loose blocks in the river, close to the places whence they were broken off. It is not always possible to say, on account of breakage, from which side of the gorge they came.

Although most of the blocks in the river came from the gorge itself, the rock fall from the cliff reaches to the very edge of the river, so it is almost certain that a number of the blocks came from the cliff. Surely the large number suggests more than just those which have fallen from the sides of the gorge.

That there was a strong earthquake in Kinsman Notch after the Glacial Period, and that this quake was the prime cause of the great rock fall, and of most of the confusion found at present in Lost River, appears likely. The movements of the joint blocks can not

be accounted for, as far as I have studied them, in any other way. The removal of a tremendous thickness of ice from the White Mountains would naturally require crustal readjustment of no small order, and hence a large earthquake or several of them would not be strange.

The evidences for an earthquake as the principal cause of the confusion in Lost River are: slickenside-like patches on a joint block over which another block had violently slipped; lateral movements among the blocks; the pell-mell manner in which the blocks are heaped; the great rock fall from the cliff, which probably came simultaneously with the shock in the river; the inadequacy of frost action to explain all of the confusion; and the elimination of the disruptive force of a moving glacier.

Although this evidence, positive and negative, does not prove that there was an earthquake in Kinsman Notch, it gives good ground for believing that there was such a shock. I have not overlooked the possibility of a local shock due to the rock fall itself. The effects observed appear too great for the vibrations a rock fall would be expected to produce.

I am greatly indebted to Dr. Philip W. Ayres, Forester of the Society for Protection of New Hampshire Forests, for guiding me to several important caverns which otherwise I must have overlooked.

Robert W. Sayles
Harvard University

AN ANALYSIS OF THE FACTORS CONCERNED IN THE HEREDITY OF COLOR IN TUMBLER PIGEONS[1]

Whereas the usual methods for study of heredity serve only to show us the relation of one character to another, this work is an attempt to give our terms concerning heredity of color a real representation in the anatomy and physiology of the bird.

Some of the factors identified in these birds by breeding experiments follow: Red (R), Black (B), Intense (I), Spreading factor (S).

The R factor (in absence of B) is associated with the formation of a melano-protein pigment, distinctly (pigeon) red in color, easily soluble in hot 4 per cent. sodium hydroxide. This pigment is found in reds and yellows. When B is present the chemical processes in the skin are profoundly changed, and a dead black exceedingly insoluble pigment is formed. B is completely dominant to R.

The effects of factor I, as seen macroscopically, are quantitative only. When I acts on red pigment there is 3.5 times more pigment formed, than when I is absent. Acting on black pigment I has a value of about 3. The physical form of the pigment is also influenced by I. In its absence red pigment exists as irregular masses, when it is present red pigment takes the form of small spherical granules about .4 micron in diameter, etc. On the other hand black pigment exists as spheres even in absence of I. When I is present black pigment sometimes may exist as rods.

The spreading factor S effects a uniform distribution of pigment throughout the barbule. When this factor is absent the pigment is aggregated in clumps, near the center of each barbule cell. This condition changes black to blue and dun to silver. The S factor also has an influence on granule form—and this influence varies with the presence or absence of I.

There is apparently a far greater mutual modification and interaction of factors in these birds than formulæ derived from external appearance alone indicate.

Orren Lloyd-Jones
Department of Experimental Breeding,
University of Wisconsin

[1] Abstract of a paper read before the American Society of Zoologists, Cleveland, January 1, 1913.

A NEW WALNUT

I think it desirable to place before the public the fact that I have been growing for eight or ten years a walnut hybrid originating from seed of *Juglans californica* which is a hybrid between that species and some tree, probably a *Quercus* of evergreen habit. As this new form comes true from seed and may be propagated indefinitely, it is worthy of a

specific name. I therefore take this opportunity of giving a few definite characterizations. A lengthy and detailed description will be issued later.

Juglans quercifolia, n. sp. The tree has a habit of growth of a *Quercus*, and in second generation forms it is more or less evergreen, that is the leaves fall late in the season and develop early in the spring. The leaves are trifoliate or unifoliate and the leaflets are circular and very distinct from those of the mother, *Juglans californica*. When there are three leaflets the terminal one is usually the larger. The tree bears nuts similar to those of the mother. The limbs have a small pith cavity which is closely septate. The catkins frequently appear on last year's wood in pairs and are closely approximate, the posterior is usually the shortest at a given date. The color of the new foliage is a darker green than is that of the mother.

NEWTON B. PIERCE

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

A SPECIAL meeting of the society was held in room 43 of the new building of the National Museum at 4:30 P.M., April 1, 1913, the president, Mr. Stetson, in the chair.

Dr. J. H. Gore, who has recently returned from a visit to the King of Siam, read a paper on "Siamese Life and Industries," profusely illustrated by lantern slides. The former included fine basketry, bronze vessels, silver vessels, matting, textile fabrics of silk and other material and hammered silver ware of admirable workmanship, the method of production being to fill a silver vessel with sand and hammer in the surface from the outside to form the ground, leaving the decorative human figures in series (beside other ornaments) in high relief. Usually the figures represent some mythological story. Dr. Gore's lantern-slide pictures of Siam included many farm-scenes, illustrations of games, festivities and elephant-capturing and views of the city of Bangkok, the aquatic human life of its rivers and canals, the palace, imperial crematories and temples, one of the latter being an exceedingly beautiful rock cavern temple of great renown.

Dr. Gore explained that the teak-wood forests and rice culture are among the chief resources of the country, most of the ship-decks of the world being supplied from the former, now managed by an expert forester, while the export of rice is very great, about seventy rice mills of modern equipment being operated in Bangkok, beside, a large amount of similar work done by more primitive methods and appliances throughout the country. The soil is of the highest fertility and unequaled depth in the main valley of the kingdom. There are about eighty miles of good roads around Bangkok and the streets of the city are well made, modern street-car lines running on some of them: but the remainder of the country is practically without roads.

The late king was notable for divers modern and enlightened reforms, such as freeing slaves, relinquishing the royal ownership in the land in the favor of those who had been long in occupancy and use of it, waiving the exemption of the royal lands from taxation and compiling and publishing an edition of the Buddhist scriptures, which he supplied to the libraries of the world.

The inhabitants of Cambodia, he said, are nearly of the same stock of the Siamese, but regarded as inferior by the latter people, whose language is nearly akin to the Sanscrit. The human images before their temples are not idols, but for ornament. There is a flame-like upward aspiring tendency in their decorative work. No magical or religious importance is attached to white elephants, so called, which are albinoes, white only in patches; but these are regarded as rarities and curiosities and as such are given to the king.

W. H. BABCOCK,
Secretary

PHILOSOPHICAL SOCIETY, UNIVERSITY OF VIRGINIA
MATHEMATICAL AND SCIENTIFIC SECTION

THE sixth meeting of the session of 1912–13 of the Mathematical and Scientific Section was held March 17.

Professor W. H. Echols read a paper entitled "On the Root of a Monogenic Function inside a Closed Contour along which the Modulus is Constant."

Professor Wm. A. Kepner read a paper on "The Food Reactions of *Amœba Proteus*," by Mr. Wm. H. Taliaferro and himself.

WM. A. KEPNER,
Secretary

UNIVERSITY OF VIRGINIA

SCIENCE

FRIDAY, APRIL 25, 1913

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE SCOPE AND METHOD OF STATE NATURAL HISTORY SURVEYS[1]

IT is a matter of common knowledge that before the middle of the last century many of the states of the union had established state surveys, and the national government was exploring the great west, fixing boundaries, locating routes and trails, and mapping the physical features in those vast areas. In both state and national surveys, geology received a large share of attention, but physiography, zoology and botany were not neglected. Many of the states, after making a recognizance of the geological features, identified and listed their plants and animals, as did the states of Maine, New Hampshire, Massachusetts, New Jersey, Ohio and Indiana. A condition to be noted in the establishment of a number of these early state surveys is that they were organized for the purpose of exploring and studying all of the natural resources of the commonwealth, scientific as well as economic. The survey of Michigan was established at the admission of the state to the union in 1837 as geological, zoological, botanical and topographic. The prevailing idea in these early surveys in the various states seems to have been what we may designate by the word *recognizance*, including geology, physiography, botany and zoology.

As the century continued through its third and entered its fourth quarter, the main attention of the state surveys became

[1] Address of the vice-president and chairman of Section G, American Association for the Advancement of Science, Cleveland, December 31, 1912.

more and more centered in things concerned with mineral wealth; surveys that formerly had included natural history became restricted to geology, and the geology was often confined to economic studies, so that more than one geologist found himself subject to censure because he wasted his time on such supposedly worthless things as fossils. However, there was a great diversity among the states in the scope of the work they tried to do; and some of them published occasionally a volume on plants and animals. One of the best of such publications is the botany of California, appearing in 1880, the work on which was done by Brewer, Watson and Gray. This is a description of species with notes on habitat and range; but the most of the botany and zoology of this period is mere lists of species, as far as state surveys are concerned.

Special note should here be made of the survey of New York, which is the only example known to the writer that from the first has continued its natural history studies.

It is evident from what has been said that 30 years ago natural history had been largely eliminated from state surveys. In recent years, however, there seems to be a slight tendency to replace this work in the state survey. It is true that the number of states adding natural history to their work within the past quarter of a century has been small, only the states of Connecticut, Wisconsin, Michigan and North Dakota; but the surveys of New York, Illinois and Minnesota have shown renewed activity in natural history within this period, and the activity of agencies outside of official state surveys may be taken as an indication that other states will soon be persuaded to resume this work. These agencies include universities, colleges or museums that are doing some work without order from the state, like the state museums of New Jersey and Louisiana; academies of science, like those in Indiana, Illinois and other states which have started surveys, some of these academies having their work published at state expense; volunteer associations, like the Botanical Seminar of Nebraska and the recent association of universities and colleges of Ohio; and, finally, individuals, like Pammel in Iowa, Hitchcock in Kansas, Nelson in Montana, Bray in Texas and Ramaley in Colorado, who contribute papers on the biogeography of their respective states, sometimes as bulletins of the institutions with which they are connected, sometimes as reports of academies, sometimes as a gratuitous paper in a geological survey.

Though we may feel encouragement over the awakening of interest in natural history, the present condition of the survey work in this subject in most of the states must be regarded as very unsatisfactory. Only 7 states are conducting continuous and systematic natural history surveys, and the most of the work done by outside agencies is more or less haphazard and sporadic. State academies seldom have funds enough to plan any large undertaking, and their future income is not sure enough to allow the laying of plans for a series of years. Men in colleges who may have started surveys give up their positions, and the work stops. Moreover, the scattering of the reports of surveys through several serials, official surveys, college bulletins, and academy reports, is not to be commended. Suppose one should wish to learn what had been published on the botanical survey of Ohio; in how many different publications would he have to search?

What is here said must not be interpreted as condemning state survey work outside of the official surveys. I am not

ignorant of the immense amount of valuable work that has been done by these volunteer agencies, work that would be still undone if it had waited for the call of the state. What a happy conjunction of ability, disposition and means was that in Nebraska which resulted in the "Phytogeography" of that state! A brilliant effect not repeated elsewhere. Also one recalls the valuable papers dealing with state vegetation in Vermont, New Jersey, Iowa, Kansas, Colorado and Texas, all done in recent years outside the official surveys. Success of this kind usually depends on the ability and activity of one or a few spirits whose mantles do not descend on their followers in office.

Besides their value to science, these efforts of individuals, academies, and other non-governmental organizations to contribute to state surveys have the valuable effect of stimulating and promoting interest in such matters till such time as the state will establish and conduct surveys at state expense. The establishment of the Biological Survey in Michigan in 1905 was the direct result of the efforts of the Michigan Academy of Science put forth for the preceding ten years.

There are probably few states in the union whose governing bodies have not been appealed to within the last quarter of a century for funds to undertake natural history surveys; and yet, in spite of all this effort, only four states within this period, to the best of the writer's knowledge, have responded with any considerable financial support—the states of Wisconsin, Connecticut, North Dakota and Michigan. The states of New York, Illinois and Minnesota began their natural history surveys before this quarter-century, and have continued them with fairly generous support.

Seeing that so many of the state governments have been appealed to for aid, and only seven are lending any considerable support, the conclusion is inevitable that the appeal has not strongly interested the governing body; or, to reduce the matter to terms of practical politics, the appeal has not aroused sufficient backing to move state executives and legislatures. What have been the terms of this ineffective appeal? Here let the writer call upon his own experience, while believing that his own experience has been that of many others.

The appeals for state aid have generally recited three classes of benefits to be enjoyed by the state from state natural history surveys. These three are classed as economic, scientific and educational. Taking a leaf from the uniformly successful experience of geological surveys, the natural history promoters have first of all argued for the economic good to the state to come from a natural history survey, in the way of better knowledge of agricultural lands, the promotion of forestry, the increase of fish and game, the discovery and combating of plant and animal diseases, etc. Although this argument has been strengthened by reference to the profitableness of the fish and game industry of Maine, by depicting the sad state of the cut-over forest lands which the survey might remedy, and by numerous other citations, the legislators seem never to be sure that the argument applies to their own state; or, they are not sure that the benefits will not come without the cost of a survey.

The trouble with the argument for economic good seems to be that it is too vague to be convincing. The state geologist in asking for his appropriation proposes to explore a district for iron or copper, or to make a report on water-power or artesian waters. Local or corporate interests force

the matter through the legislature. The committee from the academy of science in presenting to the legislature its claims for a natural history survey, unlike the geologist, seldom has a definite promise of a definite task to be performed whose conclusion will be of economic interest to the state. It may be that some advocates have the ability to convince a legislative committee of the economic value to the state of a natural history survey; but it is certain that the most of the advocates of the past have not been so highly gifted.

The second argument usually employed in furtherance of a natural history survey pertains to the benefit to be enjoyed by science. The legislators have been reminded that the pride and patriotism of the state require that she should do her part toward building the great structure on which New York and Illinois are so faithfully laboring. On this argument the scientific advocate would like to dwell; but he realizes, at least he does after a little experience, that it is one of the least effective. The legislator counts on his fingers the scientists he knows in the state, and decides to risk their displeasure.

If it be conceded that, as a means of moving legislatures, the argument for economic benefit is weak because vague; and the argument for promoting science is ineffective because the class specially interested is small; what may be expected from the third argument most often used—the benefit to education, the benefit to the schools of the state?

In attempting to answer this question, it may be said that there are several conditions favorable to the use of this argument. The number of people in the state directly or indirectly interested in the work of the schools is very large. This large body is constituted by the better educated and more intelligent citizens, and therefore one of the most effective classes of citizens. Again, the active members of this body are organized, extending from the state department of education to institutes, associations, clubs and circles, all of which could easily be reached if their influence was desired.

Some one now offers the suggestion that this proposal contains nothing not already tried, and that its use in the past has brought few results, seeing that but a paltry half-dozen states are at present conducting natural history surveys. I will readily admit that the argument has been unsuccessfully tried in several or many states within the past two decades. But I wish also to say that in my own state, Michigan, I believe it was the argument of educational benefit, more than any other, which resulted in the establishment of the biological survey in 1905. We appealed for aid in passing the bill to scores of teachers, and to several teachers' organizations. I wish also to say that the argument for educational benefit usually contains the same weakness that pertains to the argument for economic benefit: it is vague because it does not have definite tasks to propose, definite things that the survey will surely do for education. It is true that several of the reports or bulletins on biological matters, issued within the past twenty years by the state surveys of Minnesota, Wisconsin, Connecticut, Michigan and New York, are as much or more for educational as for scientific purposes. But, to my mind, the most of these are not convincing examples of the benefits which a survey can give to the schools. The most of them can not be used by the schools, either because they are not written so as to be used or they cover so large a territory that they arouse no local interest. These reports are not written wholly for science; for their descriptions and illustra-

tions are for many species little more than repetitions of what the scientist is familiar with elsewhere. Such publications therefore, are not very satisfactory illustrations of what a survey can do for the schools, either to the advocates of a bill before a legislature or to the school instructors whose aid may be sought for the bill. And if such productions seem unsuited to the purpose to those who are working for the bill, how shall these advocates employ these reports to show what the proposed survey may do? But can the argument for a state natural history survey be strengthened by holding up for its aim a definite, worthy and vote-compelling task, just as definite as the proposal of the geologist to explore an iron range?

The plan for a natural history survey which seems to me most likely to bring legislative consideration in the largest number of states, a survey which, if once started, will carry with it all that is desired for education, economics and science, is that of a *regional survey*, biogeographic in its nature, the reports of which should be so written as to be intelligible and useful to scientists, citizens and school children alike.

The method of regional surveys within a state is not new. New York uses it for the geological survey, making the unit-regions the quadrangles of the U. S. Topographic survey; and Maryland uses it, making the county the unit-region. The biogeographic method is now made to include not only flora and fauna with their distribution but also climate, topography, soil and general relation to environment. This biogeographic method of survey was used among the first by Professor Flahault, of Montpellier University, in France, and was later applied by R. Smith to survey the region about Edinburgh, and still later by Messrs. G. Smith, Moss and Rankin for Yorkshire, England. In our own country similar attempts have been made by the Botanical Seminar in Nebraska, by Hitchcock in Kansas, by Livingston in two counties in Michigan, and by the Geological and Biological Survey of Michigan in the bulletin of 1911, entitled "A Biological Survey of the Sand Dune Region of the South Shore of Saginaw Bay, Michigan." This list names but a few of the attempts at biogeographic survey work, some of which have been noted successes, while others have had inadequate publication facilities. The method has been tried and found feasible. It was used by Schimper in his "Pflanzengeographie," in Spalding's "Distribution and Movements of Desert Plants," and is now in use in the making of that excellent series under the editorship of Engler and Drude, "Die Vegetation der Erde."

A regional, biogeographic survey requires maps on which to spread data of distribution and habitat. Fortunately for the purpose, good base maps are already provided in the topographic survey of the government. Every state in the union has had a considerable portion of its area thus mapped in quadrangles of 20 to 50 or more miles square, and these maps are covered with contour lines giving just what is needed for the spreading of biogeographic data.

Conceive that a survey party goes into one of these quadrangles provided with a topographic map, that the work of the survey eventuates in a report on the phytogeography and the zoogeography of the region, that distribution data are spread on the topographic maps, that climate, soil and other physical features are given, and finally that all parts are so presented that the reading of the report and the study of the region will put the intelligent reader into possession of what that quadrangle

contains in the way of natural features and the influence of these features upon one another, and we have, it seems to me, the best kind of a natural history survey to which the state could devote its efforts.

One good report of this kind, made for a judiciously chosen quadrangle, or fractional quadrangle, would put a powerful weapon into the hands of those who are fighting for the establishment or the continuance of natural history surveys. If the report was successfully written so that it could be used by the school teachers and the schools, the advocates of a survey bill before the legislature would have a proposition just as definite in its promise as any geologist could offer for his work. If state academies of science, or other bodies who are working for the establishment of surveys, could, by their own efforts, produce one such report as a sample, it seems to me they would be able to present the strongest possible argument for the state to continue the good work, and they would find plenty of support on the part of the schoolmen and schoolwomen. Let me cite an illustration from my own state: Michigan is among the most backward in appropriating money for cooperation with the federal government in the making of the topographic survey. While some states have nearly all of their area mapped, and many states have more than a half mapped, Michigan has only fifteen to twenty quadrangles mapped. New maps have been added slowly and those interested in the survey have had to fight for every appropriation. But the people of the unmapped areas have at last discovered what these maps mean, and from various parts of the state calls for maps will be sent to the legislature just convening. So certain are the members and friends of the Geological Survey that the request for funds for topographic work will for the future take care of itself, that for the first time they will make no effort in its behalf.

So, it would seem, may it be with the natural history survey. We have tried to use the argument of financial benefit, and it has not worked. We have tried the argument of the benefit to science, and it has not worked. The trouble with the first argument seems to be that we have not and we can not clearly define the work we would do so as to be reasonably sure of pecuniary returns. The weakness of the second argument is that relatively so few citizens would be benefited. The argument for educational benefit has met with little better success than the others, but this is probably owing to lack of definite plan. There is herewith proposed a definite plan which is believed would find supporters numerous enough to be influential. This method of doing the work, even in state surveys, has been practised by Adams, Ruthven and others in this country. I am urging the adaptation of the plan for the benefit of the schools of the state, believing that it can be made the strongest possible argument for the state survey.

Suppose such a biogeographic regional survey to be in operation, and suppose the reports to be so written up and the maps to be so made that the schools could use the reports for guides in the study of the geology, geography and natural history of the region, such a treatment of the survey would also furnish guides for all that increasing number of citizens who like to study nature. The benefits to these classes of our population, the young people in the schools, and the citizens who like the outdoors, would justify the survey. But there are other benefits that would follow: The survey could be planned so as to furnish data for instruction in agriculture and forestry and other applied sciences.

This biogeographic regional survey

would have all the scientific value attaching to the taxonomy, geography and ecology of such work. But besides this, such a survey would be the very best means of discovering the special problems that should always form a part of a state survey. There has been no intention in what has been said here to limit the work of the natural history survey to the surveyed quadrangles of the Topographic Survey. Rather, it seems to me, should this be adopted as the general policy of the survey; and, if successfully done, it could be made to carry the other scientific work of the survey. Important problems in morphology and physiology would arise, and sometimes the survey would wish to explore a region sparsely inhabited, the report of the work in which would not be of immediate use to the district, but might be of great value to science.

There are still two benefits to be mentioned which I believe would follow the adoption of the biogeographic regional survey. The first is the stimulation to investigation within the state in natural science, including natural history. This stimulation would produce better work as the result of opening up multitudes of problems on distribution, habits, etc. An increase of activity in the study of scientific problems of the state would tend to produce more valuable contents both for the survey reports and for the reports of the academies of science. We might even hope to see the lists of algæ from Bermuda and the crayfish from Yucatan crowded out of these reports by the press of work done in the state.

The second benefit to follow, incident to the awakening of scientific interest in the state by the phytogeographic and the zoogeographic survey, and the problems discovered by these surveys, would be the strengthening of the state academies of science, and the better understanding and sympathy among scientific workers, and between scientific workers and teachers of science. Many of us know how hard it is to make the state academy of science a worthy and profitable institution; we know how hard it is to obtain interesting matter for the annual programs. On the other hand, we know how many teachers out in the state would gladly participate in work on some problem. Cooperation between the state survey and the academy of science offers a means for many people of some scientific ability, but not specialists, to engage in profitable work. Some of this work can be used by the survey and some by the academy of science. The survey and the academy of science should be closely allied, and generously critical of one another.

As to the organization for a state natural history survey, I have nothing to give except a word of advice to those who have to start the work with but a small appropriation. Undoubtedly it would be best to have a specialist at the head of each scientific department represented; but if the annual fund is but a thousand or two, this is out of the question. But if the fund is only a thousand dollars annually, it is better to spend half of it in the employment of a director for part time, than to attempt to direct the work by a committee. The survey needs continuity of thought and purpose and a good deal of drudgery such as a committee is not likely to perform. If the reports or bulletins are designed for educational purposes as well as scientific, see that the written matter is presented so as to be capable of the use for which it is intended; much good matter has been buried by a bad presentation. It is not of the first importance that at the very start of the new survey the time-honored desig-

nation of "Geological Survey" should be changed to "Geological and Natural History Survey." Some legislaters are fearful of the change. The important thing is to get an appropriation and start work. If a good start is made and the survey shows its desert, the change in title can come later.

In summarizing, I will but mention the few points I have tried to emphasize in this paper:

1. With but seven states in the union supporting natural history surveys, the present condition of such work the country over is unsatisfactory.

2. Though efforts have been made to induce numerous states to establish natural history surveys, such efforts have been attended with but little success.

3. The probable cause of failure lies in the difficulty experienced by the promoters of such surveys in stating definite and important results that the survey will accomplish.

4. The suggestion is made that if the plea for a natural history survey propose a biogeographic regional survey whose reports can be used as guides for study by the schools, the proposal will be definite and the object such as to interest a large body of supporters.

5. To make these reports serve the purpose of scientific treatises as well as guides to the study of natural history and biogeography, special care must be used in the organization and presentation of the material in written form.

6. The successful preparation of local guides for the study of natural history, phytogeography and zoogeography will enable the survey to carry on other scientific work.

F. C. NEWCOMBE

ANN ARBOR, MICH.

RECENT LEGISLATION AFFECTING EDUCATIONAL INSTITUTIONS IN KANSAS

THE state of Kansas, through its legislature which has just closed its biennial session, has finally decided to enter upon what may appeal to many as a doubtful experiment in educational administration, although it is hoped that a step forward has been taken. Essentially, the new arrangement consists in the application of the commission form of government, somewhat modified, to all of the state supported educational institutions.

Two years ago a bill to place the state university, agricultural college and normal school under one board of administration was passed. It will be recalled that Governor Stubbs at that time obtained the opinion of many prominent educators and administrators as to the probable success of the plan. Finding that there was almost a unanimous sentiment against this method of university administration, the governor finally vetoed the measure.

The present state officials were elected on a platform which pledged them to a reform measure which would place all higher educational institutions of the state under a single board. The motive for this change is a desire to secure a more efficient, and at the same time less expensive, administration, in that costly duplication of work in three separate institutions might be avoided without decreasing the efficiency or impairing the present high standards of all the institutions. In addition, it is believed that such a plan should lead, if properly carried out, to a better cooperation of all the parts of a complex educational system.

The act to bring about the centralization of authority in the management of the large state institutions was passed by the legislature, and signed by the governor on February 11. This measure includes the following institutions which are all placed under a single board of three members: The State University of Kansas, with the school of mines at Weir City; The Agricultural College at Manhattan, with its experiment stations located at Hays City, Dodge City, Garden City and Colby; the Normal School at Emporia, with the Manual Training Normal at Pittsburgh and the Nor-

mal School at Hays City; the Kansas School for Deaf at Olathe, and the Kansas School for the Blind at Kansas City. Even this list may not be complete, as the branch schools have been scattered generously over the state. The members of the board are to receive a salary of $3,500 each per year for their services.

An attempt to prevent political prejudices is found in the provisions which require that at least two political parties be represented, and that not more than one alumnus from any given institution may sit at the same time, on the board. Furthermore, the members must all be chosen from different congressional districts. Tenure of office as a member of the board is for four years, the appointments being made in such a way that the board can not be completely changed at any one time, except in case of disqualification and suspension by the governor.

The board is given a large hand in the management of the affairs of the institutions, being given power to elect the presidents and treasurers, to appoint all professors, instructors, officers and employees; to fix the salaries which shall be paid, and to make all rules and regulations for rank and promotion of the faculty and employees. Apparently the whole administrative policy of the institutions is placed in their hands, the presidents being merely their executors and advisers. The management of all the property, execution of all trusts, the direction of the expenditure of all appropriations, and the investment of funds received by legacy and otherwise, are also vested in this single board.

The board, which will have its central office at Topeka, will assume charge on July 1, 1913. The commission is required to visit each institution at least monthly, and to make reports from time to time of the needs of the institutions which they control for the state.

The members of the commission appointed by Governor Hodges are Ex-governor E. W. Hoch, well known as editor and lecturer; Mrs. Cora G. Lewis, who has been prominent as an organizer of school employment bureaus, and who is well known for her literary attainments; and Edward T. Hackney, of Winfield, a graduate of the University of Kansas of 1895, and a prominent lawyer. The governor seems to have succeeded admirably in a difficult task. There is general agreement that the board is well fitted for the labors devolving upon it, and the friends of all the institutions are looking forward to a larger development under the new leadership. If an optimistic outlook makes for success in these matters, then the Kansas experiment should justify the high hopes entertained for the future.

Kansas has been exceedingly unfortunate in separating all of its educational institutions, and in pursuing the policy of scattering branch schools over the state for political reasons. It is impossible for the student who desires the advantages of the several schools to enjoy the privileges of all of them at once, as in the majority of states where at least agricultural college and university cooperate in education without duplication of forces and instructional staffs. In Kansas such a form of cooperation has been rendered impossible from the outset by the establishment of the institutions many miles apart. Wise foresight would have made the present conditions impossible. In no case have the agricultural colleges or state universities succeeded so well separately as when situated so that active cooperation and conjunction of forces are possible; and it remains to be seen whether the creation of a State Board of Administration of Educational Institutions can remedy a fundamental and irretrievable mistake in educational policy.

Those who have thus far guided the institutions will cooperate with the new board most heartily, and with singleness of purpose will seek to make the departure in administration successful from its inception. If carried out in the right spirit, this attempt at correlating and unifying the educational work of the state may result in very great advantage to all the interests concerned. The results of a somewhat different plan in Iowa have been far from satisfactory to any of the institutions. Of course, it is hoped and believed

by the optimistic people of Kansas that similar results will not be obtained here.

The *logical* outcome of this new movement in Kansas would perhaps be a gradual merging of the interests of all the state schools, and the realization of a greater University of Kansas. The *actual* outcome will be watched with more than usual interest by every one who has at heart the problems of efficient and liberal university administration.

CHARLES A. SHULL

THE UNIVERSITY OF KANSAS

SCIENTIFIC NOTES AND NEWS

DR. HUGH M. SMITH, deputy commissioner of fisheries, has been appointed United States fish commissioner.

THE Chicago Section of the American Chemical Society has elected Dr. Leo H. Baekeland, of Yonkers, N. Y., to be the recipient of the Willard Gibbs medal, founded by William A. Converse. The first award was made in 1911 to Professor Svante Arrhenius, director of the Nobel Institute, at Stockholm, Sweden. The second medalist was Professor Theodore W. Richards, of Harvard University. The formal presentation of the Willard Gibbs medal will be made to Dr. Baekeland at the May meeting of the Chicago Section of the American Chemical Society. The jury of award which selected Dr. Baekeland comprised Professor Alexander Smith, Dr. W. R. Whitney, Dr. E. C. Franklin, Professor W. A. Noyes, Dr. J. D. Pennock, Professor G. B. Frankforter, Professor John H. Long, Professor Julius Stieglitz, Mr. William Brady, Mr. E. B. Bragg, Mr. S. T. Mather and Dr. G. Thurnauer.

THE American Philosophical Society at its stated meeting on April 19 elected the following members: Dr. George F. Atkinson, professor of botany and head of the botanical department of Cornell University; Dr. Charles Edwin Bennett, professor of the Latin language and literature in Cornell University; Dr. John Henry Comstock, professor of entomology and invertebrate zoology in Cornell University and non-resident professor of entomology in Stanford University; Luther P. Eisenhart, professor of mathematics in Princeton University; George Washington Goethals, U.S.A., chief of engineers of the Panama Canal; William Crawford Gorgas, Assistant Surgeon General, U.S.A., member of the Isthmian Canal Commission; Dr. Ross Granville Harrison, professor of comparative anatomy, Yale University; George Augustus Hulett, professor of physical chemistry in Princeton University; Dr. Clarence Erwin McClung, professor of zoology, University of Pennsylvania; John Dyneley Prince, professor of Semitic languages in Columbia University and president of the House of Representatives of New Jersey; Dr. Samuel Rea, president of the Pennsylvania Railroad Company; Dr. Henry Norris Russell, professor of astronomy at Princeton University; Witmer Stone, curator of ornithology of the Philadelphia Academy of Natural Sciences. Three foreign members were elected as follows: Sir Arthur John Evans, keeper of the Ashmolean Museum, Oxford; Sir Joseph Larmor, Lucasian professor of mathematics at Cambridge; and Dr. Arthur Schuster, professor of physics at the University of Manchester.

THE Lobachevsky prize of the Academy of Sciences of Kasan has been awarded to Professor F. Schur, of the University of Strassburg, for his researches in the foundations of geometry.

THE University of Edinburgh will confer the degree of LL.D. on the Hon. James Wilson, lately secretary of agriculture of the United States.

DR. ALEXIS CARREL and Dr. Hideyo Noguchi, of the Rockefeller Institute, Dr. H. M. Biggs and Dr. William H. Park, of the New York Department of Health, and Dr. John W. Brannan, of Bellevue and allied hospitals, have been made knights of the Royal Order of Isabella the Catholic by King Alfonso of Spain.

DR. THOMAS N. CARVER, of Harvard University, has been appointed by Secretary

Houston to take charge of the proposed "Rural Organization Service," a new branch of the Department of Agriculture, designed to aid the farmer in economic, social and cooperative buying and selling.

PROFESSOR FICKER, for many years assistant at the Berlin Institute of Hygiene, has been given leave of absence, so that he may take charge for one year of the bacteriologic institute at São Paulo, at the request of the Brazilian government.

PROFESSOR HEDINGER, of Basel, has been appointed director of the Königsberg Institute of Pathologic Anatomy, succeeding Professor Henke, who has been called to Breslau.

DR. A. J. CHALMERS, of Ceylon, known for his work on the etiology of pellagra, has been appointed director of the Wellcome Research Laboratories at Khartoum in succession to Dr. Andrew Balfour, who has been appointed director in chief of the Wellcome Bureau of Scientific Research in London.

PROFESSOR THOMAS C. CHAMBERLIN, head of the department of geology in the University of Chicago, and Professor Forest R. Moulton, of the department of astronomy and astrophysics, are members of a special committee of the Illinois Academy of Science appointed to recommend a revision of the present Julian calendar.

PROFESSOR CHARLES E. VAN BARNEVELD, of the school of mines of the University of Minnesota, has been offered an appointment as chief of the department of mines and metallurgy for the Panama-Pacific Exposition to be held in 1915.

DR. G. M. WHIPPLE, assistant professor of educational psychology, has been appointed as the delegate of Cornell University to the Fourth International Congress on School Hygiene, to be held at Buffalo on August 25–30 next.

DR. JOSE M. RUA, professor of biology in the University of Buenos Ayres, is visiting the universities of the United States.

THE three selected candidates for the vacant professorship of astronomy in Gresham College, London, are Mr. F. W. Henkel, Mr. A. R. Hinks, secretary of the Royal Astronomical Society, and Mr. E. W. Maunder, superintendent of the Solar Department at the Royal Observatory at Greenwich. They will each give a probationary lecture before the Gresham Committee.

DR. H. M. W. EDMONDS, of the Department of Terrestrial Magnetism of the Carnegie Institution, will head an expedition to Hudson Bay designed to secure magnetic data in the region between the Albany and Severn rivers. A special attempt will be made to locate, as accurately as possible, the focus of maximum total intensity in North America, supposed to be in the vicinity of Cat Lake, near latitude 52°.2 N. and longitude 92° W. The expedition will leave Washington in May and is expected to return in October of this year.

GEORGE B. RIGG, instructor in botany in the University of Washington, and special agent of the U. S. Department of Agriculture in kelp investigation in 1911 and 1912, is in charge of an expedition to western Alaska for the purpose of investigating the kelps of that region as a source of potash fertilizer. It is expected that a good deal of the work will be in the vicinity of Kodiak Island and the Shumagin Islands. The power halibut schooner *Gjoa* has been chartered for the trip. This expedition is sent out by the Bureau of Soils and is a continuation of the work that Dr. Frank Cameron has been directing during the past two years. The other members of the party are: Professor Robert F. Griggs, of the Ohio State University, and Mr. Sanford M. Zeller, graduate assistant in botany in the University of Washington. Dr. T. C. Frye, professor of botany in the University of Washington, is in charge of a similar expedition to southern Alaska. With him are Dr. Robert B. Wylie, professor of botany in the University of Iowa, and Mr. Dean Waynick, a student at the University of Washington. The gas boat *Zarembo* has been chartered in Seattle for the trip. Both of these expeditions will leave Seattle on May 1.

The Maryland University School of Medicine is offering a course of twenty lectures on tropical medicine under the supervision of Surgeon J. A. Nydegger, of the U. S. Public Health Service, with the assistance of Dr. C. W. Stiles, Dr. H. R. Carter, and other members of the Public Health Service.

"The Business of Agriculture in the College Curriculum" was the subject of an address to the students of the college of agriculture of the University of Illinois, given by Dean Price, of the Ohio State University, on April 11.

Dr. Lester F. Ward, professor of sociology at Brown University, and formerly paleontologist of the U. S. Geological Survey, died in Washington on April 18, in his seventy-second year.

The death is announced, on April 7, at sixty-nine years of age, of Mr. F. G. Smart, fellow of the Linnean and the Royal Geographical societies.

Dr. Georg Boehm, honorary professor of geology at Freiburg, has died at the age of fifty-nine years.

Dr. John Seemann, director of the physiological laboratory of the Academy of Medicine at Cologne, has died at the age of forty-nine years.

Professor H. Alexan Bezjian, Ph.D. (Yale, '74), teacher of physical science in Central Turkey College, Aintab, Turkey-in-Asia, died suddenly of arterial sclerosis, on February 10, 1913, in his seventy-sixth year. He was one of the most distinguished scientific men that Turkey has yet produced. His early training was received at Bebek Seminary, Constantinople, under Dr. Cyrus Hamlin, though he was born and brought up in Aintab. Except for two years spent in America in preparation, and a later year spent in France and England, he taught almost continuously in Aintab, and the neighboring city Marash, for fifty-six years. For thirty-seven years he was the senior member of the faculty of Central Turkey College, and he was in active service at the time of his death, always abreast of the times, eager for the latest news or to learn of the freshest discovery. He was the author of many newspaper articles, and of books on "Natural Religion" "Guide to the Study of the English Language" (in Armeno-Turkish and English and the first book of its kind in Turkey), and "Elements of Physics." This latter book was published simultaneously in Armenian and in Armeno-Turkish. The Armenian form is now in its second and revised edition.

A vacancy at present exists in the position of chemist, qualified in physical chemistry, in the Bureau of Standards, Department of Commerce, at Washington, D. C. This position requires a high order of scientific training, equivalent to that required by the leading American universities for a professorship in physical chemistry. The government seeks a man with a thorough and broad scientific education and several years' experience, and he must possess qualifications of a very high order in the theories of physical chemistry and their applications. He must be qualified to act as adviser in all fields where a knowledge of physical chemistry is required, and be capable of initiating and carrying out researches in the field of the bureau's varied activities. Ability to take a broad view on chemical subjects is essential. The entrance salary for this position is $3,500 a year. The government is endeavoring to find the best man available for this work. The method of selection will be similar to that of an educational institution or business organization whose trustees or governing officers desire to fill a professional or technical position. The qualifications and fitness of applicants will be passed upon by a board containing men of recognized eminence in chemistry. Candidates will not be assembled for examination, but will be rated with respect to their education and training, their technical and professional experience, and their achievements as shown by publications and results accomplished. Persons interested should write to the United States Civil Service Commission, Washington, D. C. Letters of inquiry must be received by the Commission prior to May

15, 1913. Efforts will be made to reach a decision on this appointment by June 1, 1913.

The U. S. Civil Service Commission announces an examination for associate physicist, qualified in metallurgy, to fill a vacancy in the Bureau of Standards, Washington, D. C., at a salary of $2,200 a year. There is also announced an examination for logging engineers to fill vacancies in this position in the Forest Service, Department of Agriculture, at salaries ranging from $2,400 to $3,000 a year. The duties of this position will be: (1) Planning the most effective logging development of large national forest areas; (2) determining methods and costs of logging and manufacturing national forest timber and the market value of the products; (3) appraising the value of stumpage for sale; (4) inspecting and supervising the administration of timber sales.

The Fourth International Congress on School Hygiene will be held in Buffalo, August 25 to 30. The officers are Dr. Charles W. Eliot, president; Dr. William H. Welch and Dr. Henry P. Walcott, vice presidents; Dr. Thomas A. Storey, of the College of the City of New York, secretary general, and Dr. Francis E. Fronczak, the Buffalo member of the executive committee. Delegates will attend from all the leading nations, from every college and university of note in this country and from various other educational, scientific, medical and hygienic organizations.

The following provisional program of the Australian meeting of the British Association in 1914 is published in *The Observatory:*

July 3—Leave London by direct steamer (later by overland route).

August 4—Arrive Freemantle (for Perth), Western Australia. An advance part leaving England a week earlier than the main party will join the main party here.

August 8–12—Adelaide. Lectures; receptions; excursions.

August 13–19—Melbourne. Presidential address (first part); sectional meetings, etc.

August 20–26—Sydney. Presidential address (second part); sectional meetings, etc.

August 28–31—Brisbane. Lectures; receptions; excursions.

The earliest date of arrival in England is October 3; the route is by train to Adelaide, thence by steamer (*viâ* Suez to a Mediterranean port). Returning by steamer *viâ* Thursday Island, Port Darwin, Java, Singapore and Colombo, members will reach England about October 10–18. A party visiting New Zealand for a week will probably arrive home about the end of October.

UNIVERSITY AND EDUCATIONAL NEWS

William B. Reed, Jr., whose death occurred recently in Putnam County, N. Y., has left an estate estimated at $350,000, of which $250,000 is left to Princeton University, subject to the life interest of his wife.

By the will of Addison Brown, ex-judge of the United States District Court, who died on April 9, Harvard University receives, $10,000; Amherst College, $5,000; Bradford Academy, $5,000, and 200 shares of United States Steel preferred are left to the New York Botanical Garden.

Mr. John Howard Ford has given $1,000 to Rutgers College for the purchase of the entomological library of the late Professor John B. Smith.

On May 8 and 9 the University of Illinois will dedicate three new engineering buildings. These are the transportation building, the locomotive testing laboratory and the mining laboratory. A series of addresses by eminent men in the transportation and mining fields will be features of the program.

The mayor of Dresden has published a pamphlet in which the plan for the foundation of a university in that city is described. The university is to be combined with the already existing technical and veterinary colleges. It is proposed that the city appropriate $2,500,000 (10,000,000 Marks) for this purpose, and the state a sum of $75,000 for the erection of buildings and an annual appropriation to defray the expenses of the scientific departments.

THE educational bill providing for five scholarships in each assembly district of New York state has been signed by Governor Sulzer. Each holder of a scholarship will receive from the state $100 a year for four years to be applied toward the payment of the annual tuition fee charged by the college selected, which must be within the state. Scholarships will be awarded on the basis of school standing, and when they are all filled there will be 3,000 students at one time receiving state aid.

THE Sheldon traveling fellowships of Harvard University have been awarded in the sciences as follows: Donald Clinton Barton, Cambridge, for research in geology in Europe and Egypt during the summer; Sidney Fay Blake, for research in botany in Europe; Elmer Keiser Bolton, for research in chemistry at Berlin; Richard Maurice Elliott, for research in psychology, particularly in the psychophysics of handwriting, at Berlin and in the various psychological laboratories of Germany; Harvey Cornelius Hayes, instructor in physics, for travel in the United States, between September and February, for the purpose of observing the manufacture of alloys; Sidney Isaac Kornhauser, for research in zoology at Würzburg and at the Naples Zoological Station; Edward Hale Perry, for travel in the mining districts of the United States during the summer of 1913; Joseph Slepian, for research in mathematics in Europe, and Paul Dudley White, for research in pharmacology at London and Strassburg.

THE governing body of the Royal School of Mines, which is an integral part of the Imperial College of Science and Technology, London, are about to appoint a new professor of metallurgy in the room of Professor W. A. Carlyle, who is resigning in order to resume his professional work.

PROFESSOR EDWARD L. NICHOLS, of the department of physics of Cornell University, has been appointed dean of the College of Arts and Sciences.

MARTIN JOHN PRUCHA, of Cornell University, has been appointed assistant professor of dairy bacteriology in the College of Agriculture of the University of Illinois, and assistant chief in dairy bacteriology in the Agricultural Experiment Station. He will be associated with the new head of the dairy department, Dr. A. H. Harding.

DISCUSSION AND CORRESPONDENCE

CONVENTIONAL POSITION OF MONOCLINIC CRYSTALS

A QUESTION IN CRYSTALLOGRAPHIC USAGE

TO THE EDITOR OF SCIENCE: So much of individual preference, not to say caprice, has in the past attached itself to crystallographic nomenclature and convention that it seems desirable, before introducing further innovation, to get the opinion of as many interested persons as possible as to the ultimate usefulness of any proposed change. For this reason the writer is asking space in SCIENCE, which probably reaches more of our scientific men who come in contact with crystallography than any other single publication, in order to test an idea as to the most desirable setting of crystals belonging to the monoclinic system.

It is suggested that the ortho-axis, which is customarily placed in horizontal position, be set vertically.

The objection at once presents itself that a change from the older long-established setting would necessitate restatement of the crystallographic data concerning all monoclinic substances.

It is, moreover, possible that familiarity with the ordinary types of animals has so accustomed the mind to thinking of a single plane of symmetry in vertical position that advantage should be taken of this facility of thought in presenting to students the somewhat analogous configuration of monoclinic crystals. That this argument should not be given too much weight, however, is evidenced by the fact that beginners of their own accord not rarely place the plane of symmetry of monoclinic crystal models in horizontal position, even after they have recognized the absence of other symmetry planes.

In favor of the proposed change may be cited the following arguments:

1. The conventional usage, already prevail-

ing in the tetragonal, hexagonal and orthorhombic systems, might be made general, viz., that when only one axis of symmetry is present this is set as the *vertical* axis.

2. That diameter which alone is distinguished from all those adjacent to it by its unique character would receive the unique treatment of vertical location, as is now the case in the tetragonal and hexagonal systems.

3. The lateral axes would, with this setting, be distinguished as the macro- and brachyaxes, as in the orthorhombic and triclinic systems. Every teacher realizes what a store of mental energy this would set free for more profitable application than its present task of keeping in their proper places the prefixes clino-, ortho-, macro- and brachy-.

4. The familiar spherical projections which Groth has used to show the kinds of crystal symmetry, and which are now widely used, would then have the same relative position in the monoclinic as in the other systems.

5. The failure of positive forms to occur in the upper front right octant could be obviated by placing acute β at the right of the observer, thus removing another unnecessary stumbling-block from the path of the learner.

The undersigned would be very glad to see an expression of opinion by any interested readers as to the desirability of making this change in the conventional position of monoclinic crystals.

A. C. Gill

Cornell University,
March 26, 1913

QUOTATIONS

UNIVERSITIES AND INTELLECT

Thirty-seven years ago next fall Johns Hopkins University was opened, upon an endowment estimated at less than \$3,500,000. Yesterday, it was stated that the budget adopted by the trustees of Columbia University for the expenses of the coming academic year amounted to \$3,450,000. The foundation of the University at Baltimore was widely acclaimed as an event of the highest importance and the most hopeful augury. Never before had the income of so large a fund been placed at the disposal of the trustees of any new American institution of learning; and the Johns Hopkins trustees had, in the choice of its president, and in the announced plans of the institution, made it plain that their opportunity was to be so used as to give to the higher intellectual life of the country a great and long-needed stimulus. The hope was entertained that the new university would be the means of introducing in America what had so long been vainly desired by scholars and scientists—the true university, in the European sense of the term. And that hope was not disappointed. The foundation of Johns Hopkins University marked the beginning of a distinctly new era in the history of higher education in America. What had formerly been the rare pursuit of a devoted scholar here and there has become the regular occupation of thousands of students in scores of colleges and universities. In many a field of research our country now makes contributions which, in point of quantity and sometimes also in point of quality, stand well alongside those of the leading nations of Europe; whereas, before the new start made in 1876, it was only some unusually gifted or ardent mind that went beyond the mere acquisition of the results of foreign learning and investigation.

In compassing with what would now be regarded as small means so signal an achievement, one cardinal feature of the policy pursued by President Gilman and the Johns Hopkins trustees was essential. There was one thing to which every effort was directed, every energy bent—the securing of the highest possible quality in the professors. A small group of real intellectual leaders formed the nucleus of the faculty; and in adding to them younger men in the various departments the keenest interest was constantly maintained in the discovery of unusual talent or exceptional attainment. Those who were at the university in its early years testify unanimously to the extraordinary exhilaration and inspiration of the atmosphere thus created. The buildings were extremely modest, and in large part of a makeshift character, being old residences altered at slight expense; the warning given by Huxley, in his notable address at the open-

ing, against putting into bricks and mortar what ought to be invested in brains, was rather by way of accentuating a policy already pursued than of advising its adoption. The revenue from the endowment proved to be even less than had been expected; much, it was felt, had to be done in the way of ordinary collegiate instruction to meet the needs of time and place; and if, with the means available for the distinctive purposes of the university, so great an impetus was given at Baltimore to the university idea in America, this must be ascribed, above all else, to the clear recognition of the prerogative of intellectual superiority as the one touchstone of university distinction.

The Columbia budget of $3,450,000 is typical of the present-day expenditures of our larger universities. That they accomplish great results, results of extensive and varied usefulness, no one would deny. They cover a field much larger than that which formerly comprised the activities of our institutions of learning. They do much to promote civic enlightenment, and assist concretely in the solution of many problems of government. But we doubt whether any one would so much as claim that the enormous enlargement of university expenditure has been attended with any such nourishment of high intellectual standards or ideals as might have been hoped. Indeed, many a man may be tempted to compare in this respect the big and rich universities of to-day with the struggling institutions of half a century ago to the decided disadvantage of the present. The roster of the faculty becomes ever longer and longer; but how many of the names are such as it will thrill the students to recall thirty or forty years hence? There is always danger, in such matters, of the illusion of fond memory; the shining names of teachers under whom students were proud in after years to recall that they had sat were never very numerous. Still, it ought to be possible, out of the thick volume of professors' names in the catalogue of any of our leading universities, to single out a goodly list of those whose eminence is unmistakable and impressive, whose influence counts as a great intellectual or spiritual force, whose presence gives to the university significance and dignity, to the enjoyment of whose instruction or inspiration the student will look back in after years as a never-to-be-forgotten privilege. Some such there are; but, in comparison not merely with an ideal possibility, but with what is actually found in foreign universities, they are extremely few and far between.

In comparison with this question, all matters of mere "management" are trivial. And it is for this reason, more than any other, that we have always regarded the magnifying of questions of administration in our American universities as so deplorable. To get men of real power into the professorships—that is the great problem. The question of salaries is undoubtedly a great stumbling-block; though even here the magnifying of administration adds to the difficulty, for a due recognition of the paramount importance of the professor would naturally tend to the making of such salaries as are needed to render professorships fairly attractive in a material sense. But important as this material side is, even more important are the less tangible elements that fix the character of the professorial life. These can not be had, indeed, simply by taking thought; the slow growth of tradition, and the temper of the national life as a whole, are preponderating factors. But we may help the growth of the tradition; and we may modify the influence of the national temper on the subject, for better or worse. As far back as Tyndall's visit to this country, in the early seventies, the British scientist took occasion to exhort his American audiences to prevent such waste of scientific genius as he found going on here, as illustrated in the case of Joseph Henry, abandoning physical research for administrative duties. We must make the life of the scholar and scientist attractive not merely in point of salary, but in point of honor, of leisure, of sympathetic environment; and all other tasks of university presidents and university trustees are of small moment in comparison.—New York *Evening Post*.

SCIENTIFIC BOOKS

The Eurypterida of New York. By Drs. John M. Clarke and Rudolf Ruedemann. New York State Museum Memoir No. 14. Albany. 1912. 2 vols.

This handsome memoir, illustrated by 121 text-figures and accompanied by an atlas of beautifully engraved plates, marks a notable addition to the series of special monographs published by the New York State Educational Department, the importance of which from a purely scientific standpoint can not be overestimated. Granted that a knowledge of the wonderful world we live in and of the manifold variety of life inhabiting it is of value for its own sake, even though it yields no direct material returns, there can be no question that the publication of this series of memoirs has contributed largely toward the advancement and diffusion of knowledge, in which respect the empire state long ago took the lead and has set a worthy example for sister commonwealths to emulate.

The new monograph before us is of a character such as might be expected of two authors who are recognized as holding front rank among invertebrate paleontologists. Not merely is this one of the regular contributions of trained specialists, valuable though it is as a great storehouse of facts. It is something more besides. Those familiar with the group of organisms considered must acknowledge it to be a philosophic essay which bears the stamp of authority, since everywhere one finds that conclusions have been reached only after mature deliberation, upon rigorous analysis of the evidence (often complex and confusing), and in the light of all previous researches that have been conducted in this difficult field.

As is befitting a scholarly production, the memoir is embellished by a graceful literary style, in which lucidity and directness of expression are conspicuous elements. Hugh Miller at his best could not have employed a more appropriate and smoothly flowing phrase, though he may have unwittingly inspired it, for we find his name bestowed upon one of these peculiar-looking creatures which in the parlance of Scotch quarrymen are called "seraphim."

This volume represents the fruition of long-cherished plans, and more than fifteen years of patient collecting, preparation and study of an immense quantity of material. In localities formerly productive of good specimens but now no longer worked, nothing was thought of tearing down and rebuilding many rods of stone wall and foundations of old barns, on the chance of securing a bit of fresh evidence, or of following up a single new clue. In point of diversity, the thousands of specimens which passed under scrutiny during the preparation of this memoir exceed all other collections in the world. Little wonder, therefore, that so exhaustive an investigation should have yielded important new results and thrown a flood of light upon the structure and relations of this extinct order of merostomes. In fact, the organization of eurypterids has probably been studied in greater detail than that of any other group of fossil animals, and our precise knowledge of them is comparable with that which we have of recent arachnids. The theme is a fascinating one, and touches closely on human interests when we consider the theory, recently revived in some quarters, of the arachnid origin of vertebrates.

The general thesis of the book is that eurypterids, the king crab and other merostomes are arachnids, and share a common origin with the scorpion and its allies. As for the scorpions, to which a special section is devoted in the appendix, it is worthy of note that they exceed all other animal forms of high elaboration in point of racial longevity, having had a continuous existence from the Silurian onward.

A very important chapter is that which is devoted to a comparison of the anatomical structure and larval stages of development as observed in eurypterids, *Limulus* and scorpions. The conclusions reached from this line of research are: (1) that "the limulids and eurypterids were probably separate in pre-Cambrian time"; (2) that "neither *Limulus* nor the scorpions are derivable from the

eurypterids, but that all three, while related, have early separated, and that eurypterids are still nearest in their general aspect to this common ancestor"; and (3), while we have no clue as to what this common ancestor was, it is clear that the earliest and most primitive known crustacea (trilobites) do not stand in that relation, and therefore the derivation of various types of these arachnids from arthropods more primitive than the crustaceans seems a necessary inference. It is recalled in this connection that Bernard derives the crustacea from a bent carnivorous annelid, and that Beecher regards this view as partly confirmed by his discoveries concerning the ventral anatomy of trilobites.

For the study of the ontogeny of eurypterids the authors had at their command an unrivaled series of larval stages of four genera, ranging in size from a length of 2 mm. or less up to the adult condition. A comparison of growth stages leads to the important conclusion that there is a "general parallelism in the ontogeny of the eurypterids and *Limulus*." Not less brilliant and far-reaching is the discovery that the Cambrian genus *Strabops* fulfills tolerably well our conception of a generalized prototype from which Silurian eurypterids have descended. The adult *Strabops* so closely resembles the young of later genera as to justify the statement that eurypterids actually pass through a "*Strabops* stage" during their nepionic development. Herein is found fresh evidence in favor of the so-called recapitulation theory, or biogenetic law, as important in its way as the recognition of the "*Prestwichia* stage" of *Limulus*, and the goniatitic and ceratitic stages of ammonites.

Confirmatory evidence in favor of the homologies between eurypterids and king crabs is found in the fact that *Pterygotus* and *Limulus* show a remarkable identity in structure of the compound eyes. The view of their common relationships thus receives strong support from a new body of facts, for, as shown by Watase and others, the visual organs of *Limulus* form an extremely peculiar structural type. Among the various special anatomies that have been minutely investigated, those which have to do with the compound eyes and genital appendages are particularly commendable, and the results gained are of signal importance.

The special essay on morphology and anatomy, together with the discussion as to the mode of life of these creatures, are replete with new and interesting details. Owing to limitations of space, we can only refer to these in the most casual way, and it must suffice to note merely the captions of some of the subordinate themes discussed, as, for instance, the following: Geological distribution and bionomic relations; mode of life; taxonomic relations; synoptic table of North American eurypterids. These lead up to the principal chapter, consisting of 232 pages, which is devoted to a systematic account of the group and is in every way most excellent. After this follows an appendix of 40 pages, in which are set forth the results of investigations and discoveries made since the body of the work went to press. Besides the valuable note on Silurian scorpions, already referred to, there are considered here the relations of several problematical forms, *inter alia* the pre-Cambrian bodies called *Beltina*, the genus *Hastimima* of White, and the suborder *Limulava* of Walcott. Appendices as important as this are welcome in any work for the choice nuggets of new truth they contain.

The greater part of this memoir necessarily deals with the concrete facts of observation and their adjustment to the present state of our knowledge. Nevertheless, an undercurrent of ideas appears to run through various passages, sometimes only suggested or hinted at, or again included within broad generalizations. And the central thought that informs these ideas proves to be an insistence upon the *fundamental human interest of the theme.* For really, is not the general theme one which involves questions concerning our own remote ancestry? And who knows whether we may not discover landmarks which shall point for us the way taken by advancing creation in its slow march through the ages, the end whereof is man? A gradual progression leading up to

man, that mite, that mere atom, that ephemeral fragment of nature! How insignificant a goal; and yet, strange paradox, that mite and that atom is able to comprehend nature, and great enough to know his own littleness. Alone among earth's creatures this being has intelligence fine enough to perceive that his thought is everything, even though it be "but a flash in the midst of a long night"; and even though all life be "only a short episode between two eternities."

Reflections of this sort must certainly have inspired the minds of the authors when writing many pages of this memoir; and in the reviewer's judgment the work has suffered nothing in consequence. Not long ago one Anatole France wrote a natural history of penguins. It is a capital work, and has opened our eyes to new and alluring possibilities of ornithology. But in the preface the author lays down certain rules for the guidance of fellow naturalists if they would greatly extend human knowledge and leave imperishable monuments behind them. Now assuredly Drs. Clarke and Ruedemann have done these things, as this memorial witnesses, yet they have gone exactly contrary to rule. Whence we infer that the learned academician must have been mistaken, for surely no one will accuse him of ever being ironical.

C. R. EASTMAN

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Palæolithic Man and Terramara Settlements in Europe. By ROBERT MUNRO. New York, Macmillan Co. 1912. Pp. 507. Price $5.50 net.

"This volume contains the Munro Lectures in Anthropology and Prehistoric Archeology for 1912, being the first course since the lectureship was founded," in the University of Edinburgh. It seems especially fitting that the eminent archeologist after whom these courses are named should himself be the first to fill that lectureship. A standard is given which is of the highest and which, we may hope, subsequent lecturers will strive to maintain.

Those who are not in the small circle of prehistoric archeologists are prone to look upon their work askance, if indeed they do not ignore it altogether. "Early Bronze is a good enough term for articles in a museum," they say, "but it does not suggest a spiritual being. We can not get on terms of spiritual intimacy with the Early Bronze people. For all their flint arrow-heads, or bronze instruments, we can not think of them as fellow men." These prevalent views can come only from a distorted perspective, a perspective in which only the dull unrelated side of these things is open to our vision—when we see them as objects rather than as evidences. It must be confessed that the specialist is often more than indirectly responsible for this prevalent attitude. To Dr. Munro we must feel grateful for a masterful treatise which, without neglecting the minutiæ and details, subordinates them to their true place in a scheme of wider relations. His facts are evidences, his evidences appear in their proper place in the larger *Culturgeschichte.* We can not be too grateful that, to use his own phrases, "the gnawing tooth of time" has allowed us to rescue from the "dustbins of ages" these few pages of an early history which archeological finds furnish.

The volume is divided into two parts, the first treating of Anthropology: Paleolithic Man in Europe, with supplementary chapter on the Transition Period, the second with Prehistoric Archeology: Terremare, and their Relation to Lacustrine Pile-structure. The volume covers a ground which no other English one duplicates, that of Sollas being more closely related to the first part, and that of T. E. Peet to the second.

Of the first part we have only two criticisms: A map showing the locations of the various described sites would add greatly to the value of the exposition, and a chapter dealing with the methods of burial would have been a valuable addition. The excellent maps incorporated in the author's *Lake Dwellings of Europe,* have their counterpart in the second portion of the present work, which deals with the Po Valley, and there is a chap-

ter devoted to methods of burial—not, however, giving us such valuable information in this regard as we obtain from Peet.

The author is concerned in the main with description, there being no less than 74 full-page plates in addition to the 174 figures. These excellent illustrations greatly enhance the value of the volume. We may regret that the author has not brought the problems out more sharply. The more important of his solutions of the problematic are probably these:

Pithecanthropus erectus represents a type, not necessarily intermediate between man and the monkeys, but one in which the erect posture had been assumed though the head-form of *Homo sapiens* had not completely evolved—"the seeming difference being due to the different standpoints from which the phenomena are contemplated." A *hiatus* between the paleolithic and neolithic in England must be assumed, the so-called mesolithic forms being incomplete neoliths; it is probably to be accounted for on the assumption that paleolithic man was driven out by the cold and the glaciers, to take refuge with the cave-men of France with whom he could easily communicate over the land now covered by the English Channel. Likewise, paleolithic man of Jersey could so communicate. The dual cultures found in the eastern and western parts of the Po Valley, respectively, are explained on the supposition that "the terramaricoli in their migration southwards took possession of these native villages, and lived in their hut-habitations, finding them as comfortable as their own pile-structures. If there was an emigration of terramara folk from Emilia to south Italy, who ultimately became the actual founders of Rome, surely they must have left some traces of their journey behind them. If so, what are these traces? To me the answer is not far to seek: they are scattered along the Adriatic slopes in the numerous hut-villages and cave-dwellings, which are described as containing unquestioned remains of terramara civilization." To this the classical archeologist will retort: *If there was such an emigration.*

The chapter describing Structures Analogous to Terramare in Other European Countries is most welcome, for we do not have a substitute in English.

The volume will appeal both to specialists, who will find it valuable for references, illustrations and descriptive material, and to the lay reader who wishes to have in easy, comprehensive form the latest results in European prehistoric archeology.

W. D. WALLIS

UNIVERSITY OF PENNSYLVANIA

The Cotton Plant in Egypt. By W. LAWRENCE BALLS. Macmillan & Co. 1912. 202 pages, 1 plate and 71 text figures.

The purpose of this book, as announced in the preface, is to abstract "the results of a series of researches made upon cotton plants in Egypt, which investigations, though diverse, were connected by the desire to know all that could be learned about the plant itself." The subject matter covers a wider range than is usual in books concerning cultivated plants. Morphology, physiology and genetics are treated in turn and the bearing upon agricultural practise of each phase of the investigations is constantly emphasized.

An "historical" chapter deals with the perplexing problem of the origin of the Egyptian type of cotton. Professor Balls champions the view that the existing varieties are "more or less heterogeneous complexes of heterozygotes." They are, it would appear, descended from fortuitous crosses of a brown-linted tree cotton of the Peruvian type, long existent in Egypt, with other varieties, among them probably American Sea Island, which was introduced there during the first half of the last century.

Brief accounts are given of the process of fertilization, of the development of the embryo and of the cytology of the fiber. One of the most interesting portions of the work deals with the influence of physical factors, especially temperature, light and soil moisture, upon growth and development. The author distinguishes two periods in the ontogeny of the cotton plant, the first beginning with

germination and the second with the appearance of the first flower. He believes that development is controlled during the earlier period mainly by air conditions, especially temperature, and during the second period mainly by soil conditions, especially water content. He regards as the limiting factor for growth what he terms "thermotoxy"—the supposed accumulation of injurious products of metabolism caused by high temperatures and aggravated by a deficient water supply. Varietal differences in length of the growth period would indicate corresponding differences in resistance to "thermotoxy." Experiments are described which deal with the effect of a high water table in checking root development and in inducing shedding of the flower buds. This subject is at present much discussed in Egypt in connection with the recognized deterioration of the cotton crop.

In the field of genetics fluctuation, natural crossing and heredity are treated. Much space is devoted to the application of Mendelian and post-Mendelian principles to cotton hybrids. This discussion, interesting and suggestive though it be, will scarcely inspire the cotton breeder with confidence that his practical problems will be speedily solved by the Mendelists.

By way of criticism, attention may be called to a certain lack of balance in the space devoted to different phases of the subject. Thus the morphology of the vegetative organs, which is of great interest agriculturally as well as botanically, receives but scant notice. One reads with astonishment that there is "apparent identity of all the modern varieties of Egyptian cotton in external appearance—for, even when grown side by side, they are scarcely distinguishable." Several of the varieties, when grown in Arizona from imported seed, have proven readily distinguishable by the characters of the leaves, bracts and bolls. There is also a tendency to put forth rather sweeping generalizations. Such are the assumptions, regarding fluctuation, that in a pure strain it "is the result of slight irregularities in a normally uniform environment" (p. 89) and that "physiology explains it" (p. 90). It is also not very clear to the uninitiated why transmitting power "is not a mysterious vital function" merely because it "can be reduced to formulæ." Several of the text figures are left without satisfactory explanation, either in the legends or in the text, and the reader would be saved time and trouble if the pages were cited in referring to the figures.

Nevertheless this little volume can not fail to be helpful and suggestive to all investigators of the cotton plant and not its least valuable mission is to show some of the ways by which scientific investigation of a crop plant may be brought to bear in improving agricultural practise.

T. H. K.

Naturwissenschaftliche Studien am Toten Meer und im Jordantal. Von Professor Dr. MAX BLANCKENHORN. Berlin. 478 pages with geographical map and table.

Students of the geology of Palestine probably owe more to Dr. Max Blanckenhorn than to any other one author. The present volume is an account of his last expedition undertaken in 1908 at the request of the Turkish government. The ex-sultan, Abdul Hamid II., apparently desired to discover mineral wealth in the valley of the Jordan River and Dead Sea, which is his private property. Dr. Blackenhorn, however, wisely insisted that the expedition should be primarily scientific, and not economic. The results justify his position, for Palestine is very poor in mineral wealth. Pure science, however, did not satisfy the Turkish government which still, in spite of repeated promises, owes Dr. Blanckenhorn twenty-five hundred dollars for expenses incurred at their request.

Dr. Blanckenhorn's work divides itself into three closely related parts, economic, geologic and physiographic. In respect to the first two we accept his results without question, but as to the third there is some doubt. Inasmuch as the geological formations of Palestine are almost entirely cretaceous, little mineral wealth is to be expected. The salt deposits of Jebel Usdum at the south end of the Dead

Sea would have some value if they were not so inaccessible. The same is true to a greater extent of the phosphatic rocks of cretaceous age which the author describes near Nebi Musa, east of Jerusalem, and near Es-Salt, in Moab, east of the Jordan. These latter deposits are estimated to have a market value of nearly a million and a half dollars, and perhaps much more. Nevertheless, an English company, after spending $20,000 in prospecting, abandoned its enterprise, because the deposits are so remote, and because the directors of the Mecca railway imposed such onerous conditions of carriage. The only other valuable mineral product is asphalt, with which the cretaceous strata are largely impregnated, but the quality is not high, and the arid climate, rough topography and distance from the railroad prevent its exploitation at present. In discussing all these formations—salt, phosphates and asphalt—the author's geological observations are of more value than purely economic considerations.

Throughout the volume Dr. Blackenhorn devotes himself mainly to strict geology. Unfortunately he has adopted the style of a diary in which his birthday, his bath, Turkish officials and the weather are mixed up with a great mass of minute geological details. These details are arranged according to the chance order in which he happened to see them, and hence are difficult to follow and to interpret in general terms. They serve, however, as a running commentary upon two highly valuable contributions, namely, an admirable and reliable geological map, a large part of which is Dr. Blanckenhorn's own work, and a table which sums up the pliocene and pleistocene history of Palestine. The portions of this table based upon physiographic evidence are the part of the volume open to question. A summary of late geological history as interpreted by Dr. Blanckenhorn is as follows:

Lower Pliocene, or late Miocene. Low stand of Mediterranean Sea. First upheaval of the highlands of Palestine, accompanied by east–west, or N.W.–S.E. faulting which gave rise to such features as the separation of Upper and Lower Galilee, the basin of Asochis in southern Galilee, and the fault-scarp and plain of Esdraelon between Galilee and Samaria.

Upper Pliocene. Broad encroachment of sea in Syrian Desert. Small lakes occupying parts of the present area of the Sea of Galilee. Basaltic lava flows of Banias and el-Markab. Completion of first great erosion-phase of rivers.

Gunz Glacial Epoch. Level of Mediterranean Sea 330 meters higher than now. At the beginning of this epoch the depression occupied by the Jordan Valley, Dead Sea, Gulf of Akaba and Red Sea began to take form, while at the end occurred the great movements which gave final form to the deeply depressed graben in which lie these various bodies of water. With this went considerable faulting in a N.E., S.W. as well as N. and S. direction. Conglomerates and marls were deposited in the much-expanded predecessor of the Dead Sea.

Gunz-Mindel Interglacial Epoch. This was a short dry period during which the Dead Sea contracted so far that the thick salt beds of Jebel-Usdum were deposited.

Mindel Glacial Epoch. Sea 33 to 80 meters higher than now. Culmination of glacial period with small glacier in Lebanon. Highest stand of Dead Sea, which extended from the Sea of Galilee to Wadi Araba. The strand formed at this time is supposed by Blanckenhorn to be represented by what he calls the Haupt Terrasse or Terrace of Jericho. In the Jordan Valley he assigns to this a height of 100 to 200 meters above the present level of the Dead Sea, at the north end of the Dead Sea a height of 50 meters, and at the south end a height of 486 meters. His natural inference is that there has been an unequal upheaval at the north and south, and a sinking in the middle. It seems impossible to accept this view, since, as the reviewer has shown in "Palestine and its Transformation," there are terraces at the north end of the Dead Sea much higher than 50 meters; and near the head of Wadi Kuram, in this same region, between Massaba and Nebi Musa, deposits, apparently of lacustrine origin, are found at a height of approximately 450 meters.

Mindel-Riss Interglacial Epoch. A long, dry period during which the Dead Sea fell to approximately the present level. Great erosion and much outpouring of lava.

Riss Glacial Epoch. Slight encroachment of the Mediterranean Sea, many lava flows. Slight expansion of the Dead Sea, formation of the

"middle terrace" in the deltas of various wadis. On physiographic grounds it seems to the reviewer open to question whether this terrace should be put at this time or much later.

Riss-Würm or last Interglacial Epoch. Mediterranean Sea at present level, climate approaching that of to-day.

Würm Glacial Epoch. No notable expansion of the Dead Sea. Formation of lowest terrace of the valleys, a conclusion which is open to question.

Post-Glacial Epoch. Uniform prevalence of conditions like those of to-day.

In the interpretation of rock geology, Dr. Blackenhorn is an expert, but when it comes to the interpretation of such physiographic phenomena as strands and terraces we are unable to accept his conclusions. In the first place he has failed to observe a large number of lacustrine strands which close study reveals at many points and at many altitudes around the Dead Sea. In the second place, he seems to have confused lacustrine and alluvial terraces in various places, and in the third place he has correlated terraces which apparently have no relation to one another. For instance, on page 139, when describing the Araba south of the Dead Sea, he describes a "Haupt Terrasse" with a height of 4 meters and a "Mittel Terrasse" with a height of one meter. The first of these terraces is assumed to have existed ever since the Mindel glacial epoch, and is correlated with a terrace which elsewhere is 150 meters high. He supposes the middle terrace to have originated during the Riis Glacial Epoch, and to have survived the vicissitudes of the Riis-Würm Interglacial Epoch, the Würm glacial epoch, and the succeeding period during which the climate is supposed to have remained in its present condition. Both of these terraces, it must be remembered, are in unconsolidated gravelly alluvium. It seems to the reviewer that they probably are the result of late post-glacial climatic pulsations.

In view of the diversity of results obtained by Dr. Blackenhorn and by other observers the whole question of the history of the Dead Sea from tertiary times onward needs a far more thorough and systematic examination than it has yet received. This is the more necessary since the Dead Sea and Jordan Valley contain one of the best of all records of the Pleistocene history of the drier portions of the world. Dr. Blackenhorn's excellent study of the fundamental rock structure of the region is an admirable basis for such an examination. It is to be hoped that a further step may soon be taken and that by means of a careful instrumental survey of the old strands, terraces and deposits, the physical history of the region during the last hundred thousand years or so may be conclusively determined.

Ellsworth Huntington

SPECIAL ARTICLES

THE PERFECT STAGE OF CYLINDOSPORIUM ON PRUNUS AVIUM

In the fall of 1910, at the suggestion of Professor George F. Atkinson, the writer began a study of *Cylindrosporium*, as it occurs on species of *Prunus* in the region of Ithaca, N. Y., in order to discover the life history, and the relationship of the organism on the different hosts.

Several sweet cherry trees, which had been severely attacked by *Cylindrosporium* during the previous summer, were noted and the fallen leaves observed at intervals for the appearance of an ascogenous fungus. Early in March developing fruit bodies were noticed in abundance on many leaves, some of which were brought into the laboratory and placed in a moist chamber. After a few days at the room temperature of the laboratory many of the fruit bodies showed mature asci.

Subsequent observations showed that a stroma begins to develop under the *Cylindrosporium acervuli* about the last of August. About the time of leaf fall the acervulus is cut off from the underlying stroma by a compact layer of host tissue two or three cells thick, of thick-walled cells which surrounds the whole stroma and very soon turns black. Slow internal development of this stroma continues during the winter; and by the first of May mature asci and ascospores may be found.

Ascospores were taken from these fruit bodies and placed in drops of water on the leaves of *Prunus avium* seedlings in the greenhouse. This was repeated several times and resulted in every case in abundant infection, followed in a few days by typical *Cylindrosporium* acervuli. Later pure cultures were obtained from the ascospores, and the inoculation tests were repeated, using pure cultures, with similar results.

The study of the life history, relationship, etc., of the fungus is being continued, the results of which will be published in the near future.

The fungus belongs clearly with the Phacidiaceæ and is apparently an undescribed species of *Coccomyces*. The fruit body is imbedded in the tissue of the leaf, extending usually from one epidermis to the other. At maturity the wall of the fruit body bursts irregularly on the under side of the leaf, exposing the grayish-white hymenium beneath. The asci are club-shaped with a constricted, short-pointed apex. The spores are elongate, one- to three-celled, and borne in a fascicle in the end of the ascus.

Arthur,[1] in 1887, described what is probably the same ascogenous form (or closely related species) on plum leaves which were affected with *Cylindrosporium* the previous year. A similar ascogenous fungus was also mentioned and figured on dead leaves of *Prunus* by Pammel[2] in 1892, but in neither case was the fungus named or its connection with the *Cylindrosporium* stage proved.

The question now arises as to what species name should be applied to the perfect stage. One might employ the combination *Coccomyces padi* were it not for the fact that we are confronted with certain difficulties in the use of that name. In the first place we are not certain that the European form on *Prunus padus* is identical with the American form, though there is little doubt that a similar, if not identical, ascigerous stage is present on the dead leaves of that species in Europe. Furthermore, several different names have been used for the prunicolous species of *Cylindrosporium* in North America and a similar difficulty would arise if a choice of one of these were attempted. In the second place, while a specific name already employed for an imperfect stage might be used for a new species there would always arise confusion as to what principle of nomenclature was followed in the combination if a name previously employed for an imperfect stage were used. According to the International code of nomenclature adopted at Brussels in 1910, relating to polymorphic fungi, a species name applied to the perfect stage has precedence over names applied to an imperfect stage. In order, therefore, to avoid any confusion, I propose for the perfect stage of the fungus on *Prunus avium* the name *Coccomyces hiemalis* n. sp. with the following brief diagnosis.

Coccomyces hiemalis n. sp.: *Ascomatibus sparsis* interdum subaggregatis, punctiformis, nigris, ovatis vel orbicularibus, primum claussis, deinde in lacinias plures acutas dehiscentibus; disco pallido carneo, 125–210 μ lat. ascis clavatis, crassiuscule stipitatis, $70–95 \times 11–14$ octosporis, apice papillato; paraphysibus filiformibus, simplicibus aut ramosis, apice curvato; sporidiis linearibus $33–45 \times 2, 5–3, 5\ \mu$, simplicibus aut 1–3 septatis.

Hab. In pagina inferiore deiectorum foliorum Pruni avii.

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DEPARTMENT OF BOTANY,
CORNELL UNIVERSITY

[1] Arthur, J. C., "Plum Leaf Fungus," N. Y. Agr. Exp. Sta., Rept. 5, 293–298, 1886.

[2] Pammel, L. H., "Spot Disease of Cherries," Iowa Agr. Exp. Sta., Bull 13, 55–66, 1891.

ON THE HISTORY OF COTTONS AND COTTON WEEVILS

REFERRING to my first article on the Peruvian square-weevil,[1] in which were presented data relating to the origin of the cotton plant, it now seems possible to make certain well-founded deductions. The presence of the nearest wild relatives of *Gossypium* only in the New World indicates that the stock from

[1] *Journal of Economic Entomology*, April, 1911.

which these sprang was evolved in Antarctica and spread northward during the Mesozoic after both the African and Austromalaysian connections had been broken. South America was the last of the great land masses to be cut off from Antarctica, hence only in America do we find such nearly related but distinct types as *Ingenhousia* and *Cienfuegosia*. The Australian cottons have been isolated since the southward dispersal of the type which preceded *Gossypium* and which originated in the north. Hence they are found to be farther removed from the Asiatic and American true cottons than are the latter from each other, being properly separated under *Sturtia*. They represent more nearly the immediate type from which *Gossypium* s. str. sprang.

Anthonomus is a type of North American origin, where it was dominant during the Tertiary—Oligocene and Miocene. From some of its first waves of southward dispersal sprang the group to which belongs *Anthonomus vestitus*, which latter has developed on cotton alone in South America. From a later wave of southward dispersal sprang the *A. grandis* group, this species likewise developing on cotton alone, but originating in Central America and Mexico. Almost certainly one of the periodic separations between North and South America took place while the *A. grandis* group dispersal was in progress, thus cutting this species off from South America. During subsequent connections of the two continents no extensive dispersals of these groups occurred. This explains the fact that *A. vestitus* belongs to a group not represented in North America, and indicates the great probability that *A. grandis* does not occur in South America. It also explains the now quite evident fact that both of these weevils have no other food-plant than cotton, having originally developed on that plant.

From these points we may deduce that *A. vestitus* has probably attacked cotton in humid northwestern South America for upward of a million years, if not longer. It is therefore extremely probable that this species is not confined to Peru and Ecuador.

Charles H. T. Townsend

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA

The fifteenth meeting of this society was held in Cleveland in connection with the American Association for the Advancement of Science, from December 31, 1912, to January 2, 1913. With the exception of the joint session with the American Mathematical Society and Sections A and B of the American Association for the Advancement of Science on Tuesday afternoon, December 31, the meetings were held in the recitation room of the department of astronomy of the Case School of Applied Science. The secretary of Section A has already reported on the joint meeting (see page 76 of this volume).

The time was so thoroughly filled with the program of papers that little opportunity was afforded for attendance of the meetings of the various sections of the association and the other affiliated societies, or for excursions about the city. Most of the members, however, visited the observatory of the Case School, where are housed an excellent almucantar, a zenith telescope and a transit instrument, and accepted the privilege of visiting the Warner & Swazey shops.

The following members were in attendance: Sebastian Albrecht, S. I. Bailey, L. A. Bauer, J. A. Brashear, E. W. Brown, C. A. Chant, W. A. Cogshall, W. S. Eichelberger, Philip Fox, William Gaertner, James Hartness, G. F. Hull, W. J. Humphreys, F. C. Jordan, N. A. Kent, Kurt Laves, T. A. Lawes, W. I. Milham, D. C. Miller, E. W. Morley, E. F. Nichols, J. A. Parkhurst, E. C. Pickering, J. S. Plaskett, W. F. Rigge, H. N. Russell, Frank Schlesinger, H. T. Stetson, R. M. Stewart, J. N. Stockwell, G. D. Swazey, W. R. Warner, F. P. Whitman, D. T. Wilson, H. C. Wilson, Anne S. Young, E. I. Yowell.

Visitors: G. L. Coyle, S. F. Cusick, Patrick Rafferty, J. I. Shannon.

The following were elected members of the society: W. O. Beal, J. R. Collins, Ralph E. DeLury, R. T. A. Innes, William H. Morton, Earl C. Slipher.

Abstracts of the 36 papers which were read follow in the order of presentation.

The Correction of Actinometer Measurements for Aqueous Depletion: Frank W. Very.

Tables have been prepared for the approximate correction of actinometric observations with air masses and pressures of aqueous vapor as arguments. The first table of multiplying factors is

for sea level, and the second is for the conditions and altitude (1,780 meters) of Mount Wilson.

TABLE I

Air	Pressure of Aqueous Vapor				
Mass	$1\frac{1}{4}$ mm.	3 mm.	6 mm.	9 mm.	15 mm.
$\epsilon=\frac{1}{2}$	$F=1.35$	1.40	1.52	1.63	1.86
1	1.65	1.76	2.02	2.28	2.80
2	2.18	2.35	2.66	2.97	3.60
3	2.60	2.80	3.18	3 53	4.22
4	2.99	3.21	3.58	3.96	4.71
5	3.39	3.66	4.05	4.42	5.15
6	3.69	4.09	4.54	4.88	5.56
7	4.03	4.50	4.97	5.29	5.93
8	4.40	4 91	5.43	5.75	6.25
9	4.74	5.35	5.95	6.22	6.60
10	5.10	5.83	6.43	6.78	6.95

TABLE II

Air	Pressure of Aqueous Vapor				
Mass	$1\frac{1}{4}$ mm.	3 mm.	6 mm.	9 mm.	15 mm.
$\epsilon=\frac{1}{2}$	$F=1.70$	1.76	1.78	1.80	1.86
1	2.06	2.16	2.21	2.25	2.30
2	2.34	2.45	2.52	2.58	2.63
3	2.63	2.75	2.84	2.90	2.95
4	2.91	3.05	3.15	3.20	3.25

These tables have been used to get the value ($A=FR$) of the solar radiation outside the atmosphere from observations published in Vol. 2 of the *Annals* of the Smithsonian Astrophysical Observatory. A random selection will illustrate the nature of the results.

TABLE III

Washington, D. C.			
Date	Aqueous Vapor, mm.	A	A at Sun's Mean Dist.
Aug. 24, 03	14.66	3.204	3.255
Dec. 23, 03	3.30	2.878	2.770
May 28, 04	6.50	2.855	2.920
Oct. 21, 04	7.29	3.697	3.639
Jan. 9, 06	1.96	3.227	3.106
Mean			3.185 ±0.105

Mount Wilson			
Date	Aqueous Vapor, mm.	A	A at Sun's Mean Dist.
Oct. 20, 06	1.59	3.602	3.547
June 7, 05	7.17	3.542	3.634
Aug. 22, 05	13.84	3.526	3.585
Mean			3.589 ±0.017

The data are very inadequate. The pressure of aqueous vapor is seldom recorded more than once a day, and in the absence of barometer readings I have been obliged to assume values of 760 mm. and 618 mm. for sea level and mountain, respectively. To do full justice to the method, it will be necessary to secure simultaneous observations of the distribution of aqueous vapor in the upper air by means of sounding balloon ascensions or high kite flights. No correction for atmospheric dust has been applied. The depression and the disagreement of the sea-level results are no doubt due principally to the irregular depletion by this ingredient of the lower air. This serious defect very nearly disappears on the mountain.

Astronomy in the Civil Court: W. F. Rigge.

A short time ago a man was accused in the criminal court (Omaha, Nebraska) of having attempted to wreck a cottage and kill its inmates by means of a suitcase full of dynamite. The state produced only two witnesses, who said they had seen the accused carrying the suitcase near the time and place specified. They had just come from a church a mile away, in front of which they had posed for their photograph. The position of a prominent shadow in this picture enabled an astronomer to compute the exact minute of its exposure. As this was half an hour after the time at which the suitcase had been found the testimony of science eventually freed the prisoner from fifteen years in the penitentiary. It was confirmed by the measurements and computations of a second astronomer, and by a series of three photographs exposed at intervals of one minute on the second anniversary of the taking of the original picture.

A Northern Durchmusterung: E. C. Pickering.

The Cape Photographic Durchmusterung gives the positions and photographic magnitudes of nearly half a million stars south of declination $-20°$, thus covering about one third of the sky. This great work by Gill and Kapteyn is indispensable to any astronomer studying the southern stars.

One of the greatest needs of astronomy at the present time is the extension of this work to the North Pole. A plan has accordingly been prepared for taking the necessary photographs at Harvard, with the 16-inch Metcalf telescope, with curved plates, using those sensitive to the red, as well as to the blue rays. The photometric and photographic magnitudes, on a uniform scale, will be determined for a number of standard stars on

each plate. They will then be sent to Kapteyn, who will supervise their measurement and reduction. If the entire plan can be carried out, the catalogue will contain eight hundred thousand stars, or more, and will fill at least ten volumes of the Harvard *Annals*.

The Scale of the Yerkes Actinometry: J. A. PARKHURST.

A new determination of the absolute scale for the photographic magnitudes of the Actinometry indicates that the published scale may be too extended by an amount not exceeding six per cent. The original scale was obtained from sensitometer images impressed on the plates with exposures of 10 to 20 seconds. The star images had exposures of 5 and 25 minutes. An extended series of new sensitometer exposures ranging from 5 seconds to 34 minutes indicated that the gradation was steeper for the exposures of 5 minutes and longer, than for the exposures in the neighborhood of 10 seconds. No difference was found for exposures of 5 and 25 minutes, and this was confirmed by 422 pairs of images of white stars on the zone plates. The application of the correction of — 6 per cent. brings the magnitudes into better agreement with Harvard and leaves the differences with Göttingen the same in amount but with the sign changed.

The Color Scale of the Yerkes Actinometry: J. A. PARKHURST.

A calibration of the color-sensitive plates used in obtaining the "visual" magnitudes of the Actinometry makes it possible to express the varying effect of light of different wave-lengths in difference of stellar magnitude. The spectral intensity curve is nearly symmetrical and has its maximum at wave-length 5350. The absence of selective absorption in the U-V glass of the Zeiss doublet was shown by comparison of spectra taken direct and through the glass.

On R Lyræ with a Three-prism Slit-spectrograph: SEBASTIAN ALBRECHT.

This paper gave the results of a study of two series of three-prism spectrograms, twenty-five plates in all, taken at the Lick Observatory. Following is a summary of the principal results:

1. The radial velocity of the star is — 27.22 km. per sec.

2. No periodic variation of radial velocity was found. If such a variation exists, the double amplitude of variation must be less than 1½ km.

3. Wave-lengths were determined for about 600 spectrum lines, between λ 4150 and λ 4700 ±.

4. The individual spectrum lines showed no large periodic shifts.

5. H_λ showed definite variation in intensity, though the data available are insufficient to determine definite connection with phase of light-variation.

6. The wave-lengths of the lines in R Lyræ, a star of irregular light variations, are in good agreement with the wave-lengths of lines in the *M* type stars.

7. A preliminary test of this star for spectral type, according to the method published in the *Astrophysical Journal*, March, 1911, places it at a somewhat "later" type than *Mb*, the type assigned to it in the Draper Catalogue.

A New Form of Printing Chronograph: WILLIAM GAERTNER.

This paper described in detail an instrument for recording time in minutes, seconds and hundredths of seconds, printing the records in figures on a strip of paper. The instrument is used in connection with a clock or chronometer fitted with an electric seconds contact, which operates the minute and second type wheels and controls the speed of the 0.01 seconds wheel.

The minute and second wheels are rotated by two specially designed electro-magnets which operate on pawls and ratchet wheels of 60 teeth. The seconds wheel closes a circuit when it has made a full revolution and operates the magnet which shifts the minute wheel. Both wheels can be turned independently by hand and set to coincide with the clock. The wheel printing the 0.01 seconds is automatically set to zero by the clock circuit and control magnet.

The control of the hundredths of seconds is not made directly on the type wheel, but by means of a ratchet wheel of 100 teeth, and an iron pawl engaging in it. The ratchet wheel is driven by a separate weight driven clock work, regulated by an improved form of conical pendulum friction governor. This regulator is set to run a little fast. When it has gained 0.01 second the control magnet operated by the observing clock will disengage the pawl and drop it in the next tooth of the ratchet wheel, bringing the type wheel again in adjustment. In practise the governor is adjusted so that the regulator gains about 1½ second per hour and therefore the control will take place about every 24 seconds.

The printing of the time records is accomplished by an electro-magnet which operates the printing

hammers. A paper strip sufficiently long to take about 1,200 records passes between an ink ribbon and the printing wheels and is fed through two corrugated rollers which give the spacing between records. The same current operates the printing magnet and the electro-magnet which turns the spacing rollers. A mechanism at the same time gives a shift to the ink ribbon.

Samples of the records from the chronograph were exhibited.

Circulation in the Solar Atmosphere as Indicated by Prominences: Frederick Slocum.

This paper is based upon the study of 4,600 solar prominences of which over one third either by their form or movement indicate a horizontal circulation in the solar atmosphere. The results have been classified according to direction N. or S., heliocentric latitude, and height above the chromosphere. Illustrations were shown of the types of prominences used.

The conclusions from this investigation are given in the following summary: (1) Many prominences, by their shapes or movements, seem to indicate the existence of a horizontal current in the solar atmosphere. (2) This current may have opposite directions at different altitudes in the same locality. (3) It may change its direction just as the wind changes upon the earth. (4) In middle latitudes the average tendency for movement is toward the poles. (5) In high latitudes the average tendency for movement is toward the equator. (6) This tendency is much more marked in the northern than in the southern hemisphere. (7) From latitude 10° north to 10° south the average tendency is from north to south directly across the equator. (8) The prevailing directions mentioned above are the same for prominences of all heights. (9) Upon a rotating sphere the circulation is undoubtedly spiral. The observations used in the present investigation take account only of the north and south components. The east and west components may eventually be added by an extended series of radial velocity measures of prominences. (10) Observations upon prominences within 5° to 10° of the poles are unreliable, as a prominence approaching the pole spirally may project so as apparently to be moving away from the pole.

Cosmical Magnetic Fields: L. A. Bauer.

This paper was read at the joint meeting. For the abstract see page 76 of this volume.

(Opportunity is taken here to correct an error appearing in the abstract of Professor Bauer's paper, "On the Cause of the Earth's Magnetic Field," Science, January 3, 1913, page 27. The sentence following the equations should read: These characteristic functions, $f_\sigma(u)$ and $f_s(u)$, show an increase, etc.)

Preliminary Note on an Attempt to Detect the General Magnetic Field of the Sun: G. E. Hale.

Read at the joint session (see page 76 of this volume).

Visualizing the Sun's Way: H. C. Wilson.

Two charts were exhibited showing the proper motions and radial velocities of 1,157 stars. The proper motions were taken from Boss's Preliminary General Catalogue and the radial velocities from unpublished records at the Lick Observatory. Chart No. 1 covers the hemisphere having its center at $\alpha = 270°$, $\delta = +30°$, the approximate apex of the solar motion. Chart No. 2 covers the hemisphere having the solar antapex at its center. Stars having radial velocity of approach to the sun are represented by open circles, while those which are receding are indicated by black circles. The amount of the radial velocity is represented, upon an arbitrary scale, by lines parallel to the lines representing the proper motion. Chart No. 1 indicates quite clearly that the solar apex is somewhere in the vicinity of $\alpha = 270°$, $\delta = +30°$, both by the general trend of the proper motions outward and by the prevalence of open circles near the center of the chart. Chart No. 2 shows equally well that the antapex is near $\alpha = 90°$, $\delta = -30°$, by the prevailing blackness of the star images and the general inward trend of the proper motions.

The Spectra of the Gaseous Nebulæ: Annie J. Cannon.

Of the 140 nebulæ which have been announced to be gaseous, 50 were detected and 54 others have been confirmed from the examination of the Harvard photographs. An examination of 41 of the brightest has been made for the purpose of general classification. While at least three subdivisions of Class *P* of the Draper notation are indicated, it does not seem advisable at present to assign special designations to them.

The principal class is represented by N.G.C. 7662. The so-called chief nebular lines, λ 4959 and λ 5007, are the strongest lines, λ 3726 and λ 3729 in the violet are extremely faint or invisible, while λ 3869 and λ 4686 are well marked. 28 out of the 41 nebulæ so far studied appear to belong to this general class, although 17 differ from N.G.C. 7662 in having λ 4686 absent, and

2 are peculiar in an increased intensity of λ 4363. A broad bright band approximately at λ 4363 was the strongest band in the spectrum of Nova Geminorum, No. 2, on November 9, 1912, and may be characteristic of the spectra of new stars when they become gaseous, as it is also very bright in the photographs of Nova Aræ and Nova Velorum.

A second class of the spectra of gaseous nebulæ has a line in the violet, which is probably a blend of λ 3726 and λ 3729, for the strongest line, while λ 3869 and λ 4686 are absent, and the chief nebular lines λ 4959 and λ 5007 are barely visible. No. 418 of the Index Catalogue, DM. — 12°.1172, is the only object so far found belonging to this class. Since λ 3727 and λ 5007 are both present in the spectrum of the Great Nebula of Orion, it may be intermediate between the two classes represented by N.G.C. 7662 and I.C. 418. A third division of gaseous nebulæ has λ 4686 for its strongest line. N.G.C. 40 is typical of this class, and one other $\alpha = 19^h\,0^m.5$, $\delta = -6°\,8'$ (1900), similar to it, has been found. This class of nebula is of special interest, owing to a possible connection with the spectra of Class O, in which a bright band at the same approximate wave-length is the distinguishing feature. When an object is faint, it may show only the bright band 4686, and it would then be impossible to determine, from its photographic spectrum, whether it belonged to Class O or to the third division of gaseous nebulæ. N.G.C. 40 was observed by Herschel, and a photographic chart plate shows its nebulous character.

For the purpose of comparison a composite photograph was exhibited showing the spectra of Sirius, of I.C. 418, N.G.C. 7662, Nova Geminorum II., on November 9, 1912, the same on March 13, 1912, H.R. 2583 typical of Class O*b* and N.G.C. 40.

Stellar Spectroscopic Notes: WALTER S. ADAMS.

The following notes contain some of the recent results obtained in the course of the regular radial velocity work with the 60-inch reflector.

The seven stars following are spectroscopic binaries with large range in velocity. *ξ Arietis, Boss 546*, Mag. 5.6, Spectrum B_8. The range shown by the first three plates was 57 km. On a fourth plate two spectra were visible and measures of the separate components gave a relative velocity of 262 km. The spectra of the two stars are nearly identical. *Boss 2484*, Mag. 6.2, Spectrum A_0. The range shown by three plates 88 km. *2 Comæ Berenicis, Boss 3150*, Mag. 6.2, Spectrum A_5. The range shown by three plates 53 km. *Boss 3540*, Mag. 6.8, Spectrum A_0 peculiar. Range shown by three plates 105 km. *16 Sagitarii, Boss 4613*, Mag. 6.2, Spectrum B_1, peculiar. Range shown by three plates 86 km. Traces of a second spectrum are visible. *σ Aquilæ, Boss 5018*, Mag. 5.2, Spectrum B_1. Two spectra are visible on the first plate, one of the type B_1 and the other B_2. The relative velocity of the two components on this plate is 367 km. *Boss 5070*, Mag. 5.8, Spectrum B_5. Range shown by three plates 138 km.

Two photographs of the spectrum of the star *Lalande 15290*, Mag. 8.2, Spectrum G_5, show that its radial velocity is the largest of any star observed to date in the northern sky. The spectrograms which were taken in April and November, 1912, give values of —243 and —241 km., respectively. A photograph of this star taken in December, 1910, with a temporary spectrograph gave an approximate velocity of — 250 km. Its proper motion is 1″.97 annually and its parallax is 0″.045 according to the values summarized by Kapteyn in Groningen Publications No. 24. Its velocity in space accordingly as referred to the sun is 318 km., a value only slightly inferior to that of 1830 Groombridge.

Observations of a number of the brighter stars in the *h* and χ *Persei* clusters lead to the interesting conclusion that most of these stars have nearly the same radial velocity and apparently are moving together. The stars observed are as follows:

	Mag.	Spectrum	Mean Velocity
B.D. + 57°.494	6.5	A_1	— 44
+ 56°.438	6.5	B_8	— 40
+ 56°.470	7.0	B_2	— 43
+ 56°.471	6.6	B_1	— 43
Boss 519	6.9	B_8	— 46
B.D. + 56°.530	6.9	B_8	— 45
+ 56°.568	6.7	A_1	— 45
+ 55°.612	6.3	B_8	— 46

The velocity of *Boss 519* is probably variable. The spectra of most of these stars belong to division *c* of Miss Maury's classification—that is, have relatively sharp lines. The average velocity is exceptionally high for stars of this type and this fact taken in connection with their proper motions and the similarity of their spectra makes it very probable that they form a true group. The star B.D. + 55°.598, Mag. 5.7, has a velocity of — 18 km. as determined from one plate and should additional photographs show this velocity to be constant it would seem probable that the

star does not belong to the group. The proper motions of most of these stars have been measured recently by Van Maanen and found to be extremely small and their parallaxes are below the limits of error of measurement according to Kapteyn's results.

A comparison of three photographs of the spectrum of Nova Geminorum II. taken in August, September and November leads to the following conclusions: (1) The principal nebular bands are slightly more intense on the last photograph, while the hydrogen and helium lines remain very nearly constant. (2) A very marked change occurs in the line λ 4687 of the principal series of hydrogen. On the August photograph it is very faint, while in November it is fully half as strong as the intensely bright band λ 4640. This line showed evidence of rapid variation on earlier photographs as well, gaining greatly in intensity between May 5 and May 10. Its behavior should prove of great value as bearing on the physical condition of the star. (3) Two other bands, one at λ 4522 and the other at λ 4605 are considerably stronger on the last photograph. (4) The widths of the bright bands have remained remarkably constant throughout the history of the Nova. Measures on the hydrogen, helium and nebular bands show no appreciable change from the photographs of April and May. The positions of the centers of the bands also remain as on earlier photographs, being displaced from one to two Ångstroms toward longer wave-lengths. (5) All of the more prominent bright bands except those at λ 4522, λ 4605 and λ 4640 have broad faint absorption bands nearly symmetrically placed upon them. In several cases the dark bands contain one or more narrow absorption lines. A remarkable case of this sort is the line at λ 4337.5 which has been measured upon all of the photographs taken since March. The bright bands are terminated on either side by bright maxima, the violet member of which is the strongest on the plates of August and November. (6) In addition to the bright bands the spectrum of the star almost certainly shows an extremely faint continuous spectrum probably crossed by dark lines. The *H* line of calcium is seen as a dark line on the November photograph and yields a value of the radial velocity of about + 5 km.

From these considerations it is evident that the spectrum of this Nova and probably of other Novæ as well is by no means so simple in its later history as has sometimes been supposed. The great width of the emission bands, the presence of well-defined selective absorption within them, the persistence of the displacement of their centers toward longer wave-lengths, as well as the marked variation in intensity of some of the important bands such as λ 4687, all go to show that the physical conditions present are the most complex, and must differ greatly from such as produce an ordinary nebular spectrum.

Rate of Light Changes in Various Celestial Objects: S. I. BAILEY.

A discussion of the variable stars in Messier 3 shows some examples of extraordinary rates of increase in light. This globular cluster is a faint hazy star of about the sixth magnitude to the naked eye. Its marvelous character is not suggested even in a small telescope. At Arequipa with an exposure of 100 minutes with the 13-inch Boyden Refractor about 1,200 stars were shown. These plates showed stars somewhat fainter than the 16th magnitude. Among these were found 137 variables among 900 stars actually examined for variability, or one in seven. The total number of stars in the cluster is very great. On a plate made by Ritchey on Mt. Wilson with the 60-inch reflector giving an exposure of four hours not less than 30,000 stars are seen, if we include the central mass where an exact count is impossible. Among the variables found in this cluster the maximum rate of increase in four cases appears to be more than six magnitudes an hour. The mean maximum rate of increase of all the variables is about two and a half magnitudes an hour.

It is doubtful whether any other celestial object has so great a known rate of variation as six magnitudes an hour, although it seems probable that this rate may be exceeded in the case of Novæ. Except for Novæ great rates of change appear to be rare. χ *Cygni* has a range of nearly ten magnitudes, but this enormous change takes place during so long a time that the rate per hour is only a fraction of a magnitude. Eros has perhaps the shortest period of a known object. From one maximum to the following is only about two and a half hours. The range may be a magnitude or more at times, and the light curve closely resembles a sine curve. Its maximum rate of change is probably never more than two or three magnitudes per hour. Some of the Algol variables change very rapidly. *U Cephei* and *W Delphini* are good examples. The rate per hour, however, of any known Algol star does not exceed two or three magnitudes per hour.

Relative Intensity of Prismatic and Grating Spectra: J. S. PLASKETT.

The grating spectrograph used was briefly described at the last meeting and is arranged to be used in the Littrow form, giving linear dispersion 17.5 Å per mm. and with incident and diffracted pencils 30° apart giving 33.0 Å per mm. A half prism silvered on the back can be substituted for the grating in the Littrow form, giving the same dispersion at H_γ. Comparisons of intensity were made with the Ottawa three-prism and one-prism spectrographs, giving practically the same dispersions at H_γ. Spectra of the sun and of different stars agree well in showing: (1) The grating does not diffract more than 30 per cent. of the incident light and the spectra are correspondingly weak. (2) The diffraction star spectra are practically uniform in intensity between λ 4800 and λ 3850. (3) Prismatic spectra are relatively stronger in the blue and weaker in the violet than diffraction spectra. (4) Diffraction spectra become equal in intensity to the three-prism spectra at λ 4250, to one and to half-prism spectra at λ 3970. Above these regions prismatic are stronger, below weaker than diffraction spectra. (5) The great loss of light by absorption in prisms is shown by comparison of one- and three-prism spectra. The former are more than twice as strong between H_β and H_γ, three times at λ 4250, seven times at λ 4150, fifteen at H_δ.

A diffraction star spectrograph would be of value in the ultra-violet, when spectra of uniform intensity from H_β down were required, and in the red end where prismatic spectra are unduly compressed.

A New Form of Clock Synchronization: R. MELDRUM STEWART.

The form of synchronization described is adapted to the case where both the synchronized and the synchronizing clocks control electric circuits. In the particular case where it is applied at the Dominion Observatory the synchronizing clock controls a circuit which is closed every alternate second, while that controlled by the synchronized clock is closed for one second every minute, for the purpose of operating electric "minute jumpers." Each of these circuits operates a relay, and it is the coincidence of the opening of the relays which forms the automatic test of synchronism, which takes place every minute. In addition there is used a neutrally adjusted polar relay; the circuit from a local battery is so arranged that, once a minute, while the relay operated by the controlled clock is closed, current flows through the winding of the polar relay, the direction of the current depending on the position of the armature of the relay operated by the synchronizing clock. Thus, at the instant of the opening of the relay operated by the controlled clock, the position of the armature of the polar relay depends on whether the "synchronizing" relay is open or closed (that is, on whether the controlled clock is slow or fast); and since the polar relay is neutrally adjusted, it will remain in the same position until current next flows through it, *i. e.*, until the next even minute. As soon as the relay operated by the controlled clock has opened, its back contact is utilized, in series with the points of the polar relay, to send a current through one or other of two magnets in the clock case, and so to either add to or remove from the pendulum a small weight, so as to accelerate or retard the clock for the following minute. At the end of the minute the automatic comparison is again made, and the clock again accelerated or retarded as required.

The controlled clocks are not particularly good timekeepers, and are exposed to considerable vicissitudes of temperature; to ensure satisfaction the correcting weights are made capable of taking care of a variation in rate of 8 or 10 seconds per day; the synchronization is in this case effective to within about a hundredth of a second. In the case of a high-grade clock very much smaller correcting weights could be used, and the interval between the automatic comparisons could be increased to perhaps an hour.

The principal advantage of this type of synchronization is that there is no possibility of stopping the controlled clock by interference with the synchronizing current, an advantage which, so far as I am aware, is not shared by any other method.

An Investigation of the 9.4-inch Photographic Objective of the Shattuck Observatory: H. T. STETSON.

The original 9.4-inch visual lens by Alvan Clark has been made convertible into a photographic by the substitution of a new flint, giving a focal length of 10 feet 6 inches. Measurements of extra focal plates taken after Hartmann's method for determining aberration errors show extreme variation in the focus to be less than one part in 3,000 for the same wave-length. The greatest irregularities lie in zones of 55 cm. and 85 cm. radii, where

there is marked shortening of the focus. Computation of the "criterion" constant gives $T = 0.33$, placing the quality well within the highest class.

The mean diameter of the confusion disk, when expressed in seconds of arc, becomes 0".69 as against 0".45 for the 40-inch Yerkes. The theoretical resolving power of a 9.4-inch is 0".52, whereas for the 40-inch it is 0".12. It is suggested that a criterion to best represent the quality of the optical work should involve this constant for any given aperture. This would appear to favor the quality of the smaller lens. This ratio might well be called a "coefficient of resolution."

On the Luminous Efficiency and Color-index of a Black Body at Different Temperatures: HENRY NORRIS RUSSELL.

The curves of spectral sensitiveness given by Parkhurst in his "Yerkes Actinometry" (with the addition of certain data very kindly communicated by Professor Parkhurst) make it possible to compute the luminous efficiency of a body radiating according to Planck's law at any temperature, that is, the ratio of its actual visual or photographic brightness to that of a body radiating the same amount of energy, but all of the wave-length of greatest visual or photographic efficiency. The results here given are provisional, and may be somewhat altered when fuller data regarding the spectral sensitiveness become available.

The visual luminous efficiency is a maximum for a temperature of about 7,500°, its value being 0.11. The visual surface brightness, on the Yerkes scale, varies with the temperature very nearly as the intensity of monochromatic radiation of wave-length 0.541 μ, and the photographic surface brightness like that of wave-length 0.428 μ, the deviations averaging less than $0^m.07$ for temperatures between 2,000° and 25,000°. The color-index can be still more closely represented by the formula

$$\text{Phot.} - \text{Vis.} = \frac{7500^\circ}{T} - 0^m.70,$$

the residuals averaging only $0^m.02$.

For the Harvard visual and photographic observations the mean effective wave-lengths appear to be 0.516 μ and 0.419 μ, and the color-index is given by the equation

$$\text{Phot.} - \text{Vis.} = \frac{6900^\circ}{T} - 0^m.60.$$

The "black-body" temperatures corresponding to the color indices of stars of the various spectral types may now be determined. The Harvard and Yerkes data give effective temperatures (ranging from 23,000° for Class B_0 to 3,100° for Class M and 2,300° for Class N), which are in excellent agreement with one another and with the previous determinations of Wilsing and Scheiner by visual spectro-photometric methods.

It appears also that the relative visual surface brightness of any two "black bodies" at different temperatures, if expressed in stellar magnitudes, should be 3.8 times the relative color-index on the Yerkes scale, or 4.3 times the color-index on the Harvard scale. The luminous efficiency is almost constant for color-indices between 0.0 (Sp. A) and 0.7 (Sp. G), but falls off rapidly for bodies at lower temperatures.

If these results, which are strictly true only for theoretically perfect radiators, apply approximately to the actual stars, and we could measure the brightness of the latter by means of their whole energy radiation, instead of a narrow spectral region, stars of Class K would seem about twice as bright, those of Class M four times as bright and of Class N more than twenty times as bright as they do now, in comparison with stars of Classes A to G. This would profoundly modify our estimates of the relative abundance of stars of different spectral types.

The Eclipsing Binary ε Aurigæ: HARLOW SHAPLEY.

More than five thousand observations of the variable star ε *Aurigæ,* made by Schmidt throughout the interval from 1843 to 1884, have been studied by Ludendorff, who deduces a period of light variation of 27.1 years and a light curve similar to those of certain eclipsing variables. Only three minima have occurred since the discovery of the light fluctuation by Fritsch in 1821. A study of the light curve by the writer shows that the observations can be satisfactorily represented by the eclipse theory. An accurate orbit is not possible, notwithstanding the large number of observations, but limiting sets of elements have been derived. The eclipse is total—the small bright star being completely hidden for more than a year behind the faint companion, whose volume is one thousand times the greater. The component stars are distantly separated. The mean density of the smaller component, if the masses are approximately equal, is not unusual in comparison to the densities already found for *W Crucis* and *RZ Ophiuchi,* whose periods of 198 and 262 days, respectively, are the longest heretofore known. The density of the big com-

panion, however, is about one millionth that of the atmosphere at the earth's surface. This greatly surpasses the rarity of any other known eclipsing star, but even then must be considered stellar rather than nebular. The sun extended to Jupiter's orbit would not be so dense as this, and seen from a neighboring star would certainly appear as a stellar point. Except near the limb, the larger component will be perfectly opaque. Through the center of the star the extinction must be nearly 40 magnitudes, if the mass is taken equal to the sun's mass. To allow for the translucence near the beginning and end of eclipse, the relative radii of the stars must be reduced still further, which would tend to make the density of the smaller star entirely normal without materially diminishing the density of the large component. The elements of the best orbit, which allowed for darkening to zero at the limb, are as follows: ratio of stellar radii, 0.10; inclination, 77°.0; radius of large star (distance of centers, unity), 0.397; light of each component, 0.50; relative surface brightness, 0.01; hypothetical secondary minimum, $0^m.004$; "equal-mass" densities, 2.4×10^{-9} and 2.4×10^{-6}.

Harvard classes the spectrum as F_6p. Ludendorff finds peculiarities in the radial velocity, and is making a detailed spectroscopic study of the system.

Film Distortions on Small Photographic Plates: F. E. ROSS.

By means of a reseau, tests were made of the film distortions on the small photographic plates used in the photographic zenith tube at Gaithersburg, Md.

The cut Lumiere Sigma plates are 37 mm. long by 27 mm. wide.; in all forty plates were measured, of which 20 were dried in air in the usual way, and 20 were immersed in alcohol before drying. Distortions in only one coordinate, the plates' length, were measured. The air-dried plates showed large, irregular distortions. The probable error of a measured 2 mm. space was $\pm 1.5\,\mu$; of a 22 mm. space, $9.6\,\mu$. For larger distances the probable error was somewhat smaller. The corresponding probable errors of alcohol-dried plates were $0.7\,\mu$ and $2.7\,\mu$, respectively. The probable error of an average distance on air-dried plates was $6.5\,\mu$; on alcohol-dried plates $1.4\,\mu$.

The maximum distortion observed on an air-dried plate was $49\,\mu$; on an alcohol-dried plate $10\,\mu$.

Air-dried plates always showed an expansion over about three fourths its distance from the center. At this point the expansion, which amounted to $19\,\mu$, ceased, but the irregularities became a maximum.

No certain expansion of the alcohol-dried plates could be detected. Air-dried plates which showed unusually large distortions were resoaked in water, dried in air and remeasured. The distortions were found to have been notably changed, in both distribution and amount. They were again well soaked and measured while wet. The distortions were found to have disappeared. Other air-dried plates showing large distortions were resoaked and redried in alcohol. The distortions disappeared in this case also.

Some Effects of Radiation upon Astronomical Instruments: F. E. ROSS.

Read, but no abstract was submitted.

Recent Progress in the Theory of the Galilean Satellites of Jupiter: KURT LAVES.

The paper is a part of a report concerning the Theory of Satellites in the Solar System, which will appear in Vol. VI. of the "Encyclopaedie der Math. Wissenschaften," published by the Academy of Sciences of Göttingen.

The modern investigations of de Sitter, Cookson, Sampson and others were considered, and attention was drawn to the fact that the old Laplace-Souillard theory is inadequate from a modern standpoint.

The Solar Rotation in 1912: J. S. PLASKETT.

Two series of rotation plates were obtained in 1912, though with great difficulty, owing to cloudy and hazy weather. The first of these series, center at λ 5600, the special region allotted to Ottawa, was obtained during June, and the second, center at λ 4250, the general region, during October. The first series, consisting of 25 spectra at each of the latitudes 0°, 15°, 30°, 45°, 60°, 75°, 80°, 85°, was measured and reduced by the writer, and the velocity values obtained are well expressed by a formula of the Faye type.

$$V = (1.431 + 0.563 \cos^2 \phi) \cos \phi,$$

where V is the linear velocity in kilometers per second and ϕ the heliographic latitude. The coefficients of this formula lie between those of the two series obtained in 1911 and the observed values for the two years are in good agreement, the only differences of any magnitude being at latitudes 45° and 75°, where the 1912 value is about 0.04 km. per second lower. The measurement and reduction of the other series will likely give defi-

nite information as to the best value of the coefficients of the formula and as to the discrepancy at the two latitudes.

Orbital Planes of Binaries: JOHN M. POOR.

The paper gave a preliminary statement in regard to a statistical method of investigating the parallelism of orbital planes of binary stars to any particular plane in space.

The several attacks upon the problem of determining whether the orbital planes of binary stars are parallel to any particular plane in space have led to no very positive indications that such parallelism exists in the case of the best determined orbits of binary stars.

If such parallelism exists it ought to be indicated in a statistical study of measures of binary stars by the systematic variation in magnitude for different parts of the sky of the correlation coefficient expressing the relation between position angle and distance of the doubles in a limited area of the celestial sphere. As this problem is more easily solved in rectangular than in polar coordinates, it may be put in the form of finding the correlation between $s \cdot \sin P (= x)$ and $s \cdot \cos P (= y)$.

With a view to making a study of this question along these lines the necessary computations have been begun at the Shattuck Observatory, though a sufficient number of correlation surfaces has not yet been computed to allow conclusions to be drawn.

It is hoped that double star observers to whose attention this preliminary statement may come will cooperate by furnishing the writer with lists of their observations published since the appearance of Burnham's General Catalogue in order that the final computations may be based on as large an amount of material as possible.

On Climatic Changes and the Cause of Ice Ages: W. J. HUMPHREYS.

Numerous geological records give evidence of great climatic changes in the past, culminating at times in excessive heat and aridity and at other times in extreme cold and corresponding precipitation. It appears too that the great climatic changes were simultaneous and in the same sense the world over—warmer everywhere or colder everywhere. Hence, whatever the chief cause of these effects, it must have been world-wide.

Certain variations of long duration in the energy output of the sun would meet the above conditions, but the cause of such variations is not apparent nor is there other evidence that they ever actually took place. Hence it seems well to seek for some general terrestrial cause of climatic change—for something in or of the atmosphere.

More or less continuous pyrheliometric records since 1880 show marked deficiencies in the amount of solar radiation received at the surface of the earth during the years 1884, 1885, 1886, 1903 and since June, 1912. The first of these periods followed the explosion of Krakatoa, the second the explosion of Mount Pelée and the third that of Katmai in Alaska. The only other minimum of importance, about half as great as those just mentioned, occurred in 1891 and presumably was also connected with a volcanic explosion.

Now the fine volcanic dust, roughly one micron in diameter, when thrown into the isothermal region of the atmosphere must settle slowly, since it is above the reach of clouds, and spread over all parts of the earth, as we know it did after each of the above-mentioned volcanic explosions. Further, the fine dust *scatters* the short wave-length solar radiation to a much greater extent than it does the relatively long wave-length earth radiation. In other words, earth radiation gets out through this enveloping layer of dust much better than solar radiation can get in. Hence the final equilibrium temperature of the earth as a whole, other things being equal, necessarily is lowered by the presence of a dust veil in the upper atmosphere. In the cases cited above the decrease of insolation seemed sufficient, if long continued, even to bring on an "ice age."

During the geological past there have been several periods of great volcanic activity with intervening ages of volcanic quiescence, just as there have also been ages that were warm and dry alternating with others that were cold and wet.

From the above considerations it is suggested that the alternate presence and absence, each for long periods, of volcanic dust in the high atmosphere may have been an important if not even the controlling factor in bringing about the great climatic changes of which geological records furnish abundant proof.

Photographic Magnitudes of the Brighter Stars of the Polar Sequence: FREDERICK H. SEARES.

The investigation of the magnitude scale of the Polar Sequence previously reported has been extended by photographing the brighter stars with diaphragms and screens producing apparent magnitudes between 10.5 and 15.5. The actual magnitudes were found by comparison with the fainter stars for which the scale had previously been

established. The results for any given diaphragm or screen establish a scale for the bright stars which should be homogeneous with the adopted scale for the faint stars, and, as far as the slope is concerned, independent of the reduction constant of the diaphragm. With one exception, the results for all the diaphragms and screens used are in substantial agreement, and show a mean divergence between Mt. Wilson and Harvard expressed by

$$\text{Mt. W.} - \text{H.} = + 0^m.33 + 0^m.075(M - 10.5).$$

The formula holds between magnitudes 2 and 10.5. From 10.5 to 15.5 the scales are parallel, with the constant difference $+ 0^m.33$. The Mt. Wilson results agree closely with those of Parkhurst and Schwarzschild, which extend from magnitude 4.0 to 7.5.

The Photographic and Visual Light-curves of RR Draconis: Frederick H. Seares.

At the fourteenth meeting of the society an announcement was made concerning the photographic variation of the Algol star *RR Draconis.* The eclipse is necessarily that of a bright object by a larger and fainter companion. The relative amounts of light are approximately as 32 to 1, and probably the larger object is the redder of the two. The photographic variation should therefore exceed the visual. This hypothesis was tested by photographing the star upon ordinary and isochromatic plates, the latter being used in connection with a yellow filter. The photographic and photovisual magnitudes of the comparison stars were determined by the use of diaphragms, the zero points of both scales being fixed by comparisons with the Harvard Polar Sequence. The greater photographic range is clearly shown. The results are

	Photographic	Photovisual	Color-Index
Maximum	9.64	9.98	— 0.34
Minimum	13.46	13.23	+ 0.23
Amplitude	3.82	3.25	0.57

The epochs of photographic and photovisual minima are probably the same. The maximum difference permitted by the present series of measures is 0.002 day, the photovisual minimum following the photographic.

Some Recent Changes in the Spectrum of Nova Geminorum No. 2: R. H. Curtiss.

On December 4, 1912, Nova Geminorum No. 2 was found to be passing through a period of marked light recovery. Its brightness, 7.5 magnitude, was identical with its former value seven months previous or about eight weeks after discovery. During two weeks following December 8 the Nova faded rapidly down to magnitude 8.8. Visually the Nova was of a decided greenish-blue color during this period. The spectrum, however, underwent some marked changes.

At the brighter phase of the Nova's recovery the hydrogen lines and λ 4635 had developed greatly in strength and intensity, but with declining light the nebular lines had become the strongest feature of the spectrum. Our observations indicate that the nebular lines actually gained in brightness or at least held their own while the total light of the star waned, but during the same interval the hydrogen lines faded rapidly.

Radial velocities from the dark H line of calcium agree with the value of ten kilometers per sec. positive, obtained shortly after the Nova's discovery.

Do the Declinations of the Accepted Fundamental Catalogues Represent the True Positions of the Stars? W. S. Eichelberger.

From two papers presented at the Ottawa meeting by F. B. Littell, on the work of the 6-inch transit circle, and on the work of the altazimuth at the Naval Observatory it appears that the declinations of the stars in Boss's General Catalogue culminating south of the Washington zenith require a correction of about $+ 0''.5$.

This result is confirmed by the results in the volume of the Greenwich Observations for 1908, and the results obtained with the 9-inch transit circle of the Naval Observatory. Further, the 9-inch results show a practically constant correction from declination $- 30°$ to declination $+ 45°$, a rapid but nearly uniform decrease in the size of the correction from declination $+ 45°$ to declination $+ 60°$ and a nearly zero correction from that point to the pole. The rapidly changing correction a few degrees north of the zenith with a constant correction through the same zenith-distances south of the zenith would indicate that the fault can hardly be in the instrument. Can it be in the declinations of the fundamental catalogue?

If there is a discontinuity at the zenith in the determination of declinations at the various European observatories due either to the instrument or to the observer, such an error as supposed may have been introduced into the fundamental catalogues.

The following table, giving the differences between the declinations of three pairs of Pulkowa and Greenwich Catalogues, shows that such a discontinuity exists at least in some of the catalogues.

Decl.	No. Stars	$P_{45}-G_{45}$	Decl.	No. Stars	$P_{65}-G_{72}$	Decl.	No. Stars	$P_{85}-G_{80}$
71° to 65°	10	−0″.03	72° to 65°	15	−0″.08	72° to 63°	16	+0″.15
65° to 61°	8	−0.13	64 to 60	10	−0.10	63 to 60	10	+0.24
Pulk. Zen.								
60° to 55°	13	+0.03	60 to 55	14	−0.63	60 to 56	12	+0.20
55° to 51°.5	6	−0.11	55 to 51.5	11	−0.62	56 to 51.5	13	+0.16
Green. Zen.								
51°.5 to 45°	19	−0.46	51.5 to 46	13	−0.79	50 to 45	18	+0.06
45° to 40°	15	−0.44	46 to 41	14	−0.99	45 to 40	18	−0.07
			41 to 35	14	−0.81			

A discontinuity at the zenith of about 0″.5 is indicated in the Pulkowa Catalogue of 1865, and another of about 0″.4 in the Greenwich Catalogue of 1845.

About half the circumpolars at Pulkowa culminate south of the zenith at their upper transit, and these should give a different latitude from those that culminate north of the zenith at their upper transit, if there is a discontinuity at the zenith. Therefore all the circumpolar observations of the above-mentioned Pulkowa Catalogues were rediscussed to obtain new corrections to the adopted latitude and refraction, introducing into the equations of condition a term (z) to allow for the discontinuity at the zenith.

In the 1845 catalogue all the 110 circumpolars were included in the discussion instead of restricting oneself to the 43 used for a similar purpose in the introduction of that catalogue, and in the 1865 catalogue all of Gyldén's zenith distances were increased 0″.15 to correct for the relative personal equation of Gyldén and Nyrén.

The results of this rediscussion of the Pulkowa observations are as follows:

Z (Decl. south of zenith relatively too small)

1845	+ 0″.09	± 0″.14
1865	+ 0″.37	± 0″.10
1885	+ 0″.12	± 0″.08

	Refraction Constant		Refraction Constant of Catalogue
1845	57″.47	± 0″.064	57″.56
1865	57″.45	± 0″.045	57″.56
1885	57″.38	± 0″.035	57″.37

	Latitude			Latitude of Catalogue
1845	59° 46′	18″.75	± 0″.10	18″.67
1865		18″.67	± 0″.07	18″.54
1885		18″.55	± 0″.06	18″.54

These values of the constants of reduction give the following corrections to the published declinations:

Decl.	1845	1865	1885
50°	+0″.14	+0″.33	+0″.07
25	+0.20	+0.38	+0.07
0	+0.29	+0.50	+0.06
−25	+1.13	+1.54	−0.03

Orbit of the Spectroscopic Binary π^5 Orionis: Oliver J. Lee.

The variable velocity of the star π^5 *Orionis* was announced by Frost and Adams with measures of seven three-prism plates in the *Astrophysical Journal*, 17: 151, 1903.

The following elements have been derived from these measures and from the writer's measures on fifty-seven one-prism plates taken with the Bruce spectrograph in the interval 1907–12:

Period	3.70045 days
Eccentricity	0.051
Longitude of periastron	84°
Semi-amplitude of oscillation	58.6 km.
Velocity of system	+ 23.7 km.
$a \sin i$	2,978,000 km.
Time of periastron passage	1907 Dec. 8.83
	or J.D. 2,417,918.83

The Expression of Pivot Errors by a Formula: R. Meldrum Stewart.

Even the best measurements of pivot errors of a meridian circle or transit instrument are of course affected by accidental errors, and in the case of fairly good pivots these are no doubt larger than the actual deviations of the pivots from a smooth curve. It then becomes a question what pivot corrections should be adopted both for the positions in which the errors have been observed and for intermediate positions. In a recent series of measurements at the Dominion Observatory it was found that a good representation could be obtained by the use of a Fourier series, and it seems probable that the values so adopted are more accurate than the actual observed values.

It is evident that a Fourier series can be made to represent the observed values to any required

degree of accuracy; for example, the use of 72 unknowns would reproduce the observed values exactly, in the case where the intervals are 5°. Since, however, these observed values contain errors of measurement, it is probable that a more exact representation of the actual errors will be obtained by omitting the terms with small coefficients; if this be granted, the number of terms to be retained may in any particular case be decided by a computation of the probable error of a single observation. As several independent measurements of the pivot errors are usually made in a series, the probable error of a single observation may be computed directly from the residuals; if now we have a formula which is assumed to represent the actual pivot errors, the differences between the observed values and those computed from the formula may be used to form another probable error; the relative magnitude of these two probable errors will furnish a criterion as to the number of terms required in the formula. The freedom of the residuals from any systematic tendency will of course furnish the final test as to whether or not the formula is suitable.

In the actual determination referred to, which was made by the microscopic method, eight complete measurements were made; the probable error of a pair of microscope pointings (treated as a single observation) was found to be 0.0015 sec.; four terms of the Fourier expansion were found to be sufficient to reduce the computed probable error to the same value, and the resulting formula was adopted as definitive. This formula, expressing the necessary corrections to the observed collimation, was

$$\begin{aligned}\Delta c = 0^s.0010 \cos (2\theta - 188° 29') & \\ + 0^s.0117 \cos (3\theta - 3° 17') & \\ + 0^s.0021 \cos (4\theta - 59° 45') & \\ + 0^s.0008 \cos (5\theta - 121° 58'), &\end{aligned}$$

θ being the zenith distance. The residuals from the formula were satisfactorily small (in no case exceeding 0.002 sec.) and appeared to be purely accidental.

Values of the formula were computed for different zenith distances, and from these a table was prepared giving the zenith distances at which the value of Δc changed from one unit (in terms of 0.001 sec.) to the next; it is this table which is used in the reduction of transits.

The Variable RV Capricorni: S. D. TOWNLEY.

The variability of *RV Capricorni* was discovered by Götz in 1905. From fourteen photographic observations scattered over an interval of five years he deduced a light curve of the Algol type. Seares and Haynes observed the star in 1906 and found a light variation of the antalgol type, with an approximate period of $10^h 44^m.6$. The star is classed as an antalgol by Hartwig, and Seares's epoch and period are used in computing the ephemeris.

During the summer and fall just past *RV Capricorni* was one of a list of variables observed by the writer with the 12-inch refractor and Rumford photometer of the Lick Observatory, the use of which was kindly granted by Director Campbell. Three well-determined maxima were obtained and these show that the Seares ephemeris now needs a correction of about $3^h 10^m$—the observed maxima coming that much before the computed.

By comparing a well-determined maximum obtained on October 11, 1912, with the first one obtained by Seares, August 13, 1906, a period of $0^d.447573$ has been derived, while the period determined by Seares is $0^d.4476$, which is therefore correct to the number of decimals given.

The observations show conclusively that this star is not of the Algol type, but there is perhaps some question as to whether it belongs to the antalgol or to the cluster type. Additional observations near minimum brightness, which I hope to obtain next summer, will be necessary to decide this point.

Notes on the Real Brightness of Variable Stars: HENRY NORRIS RUSSELL.

The number of variables and of stars having peculiar spectra contained in Boss's Preliminary General Catalogue is large enough to enable an approximate estimate of their mean distance and real brightness to be made by the method of parallactic motion. Assuming that the sun is moving towards 18 h., + 30° at 19 km. per second, the following values have been found, in the usual way, from the data of Boss and Campbell, for the parallactic motion M, the mean proper-motion τ at right angles to the parallactic motion, the mean parallax π, the mean peculiar velocity—τ km. at right angles to the line of sight and the solar motion, and ρ in the line of sight, and finally the absolute magnitudes corresponding to the mean observed magnitude and mean parallax. Data for three groups of stars selected at random from Campbell's list of stars of Class B are added to test the value of the method for small groups, and some of the results of Campbell for large numbers of stars are added for comparison.

Objects	No.	Magnitude		M	τ	π	τ km., km.	ρ km.	Abs. Max.	Mag. Min.
		Max.	Min.							
Cepheid variables	13	4.3	5.1	0″.015	0″.007	0″.004	8	9	—2.8	—2.0
Long-period variables	12	4.5	9.4	0.048	0.073	0.012	28		—0.1	+4.8
Irregular variables (Spectrum M)	11	3.7	4.9	0.060	0.042	0.015	13		—0.4	+9.8
Stars of Sp. O to O_{e5}	24	4.95		0.016	0.006	0.004	7		—2.0	
Stars whose spectrum shows bright hydrogen lines	50	4.53		0.028	0.009	0.007	6		—1.3	
Random groups of stars of spectra B to B_5.	12	3.9		0.024	0.009	0.006	7	5	—2.2	
	11	3.7		0.036	0.007	0.009	4	6	—1.5	
	11	3.7		0.048	0.011	0.010	5	6	—1.3	

Campbell's Results

Spectrum B	180	4.07	0.008	0.006	6.2	—2.1
F	180	(4.3)	0.108	0.035	14.4	(+2.0)
G	118	(4.3)	0.075	0.022	15.9	(+1.0)
M	71	(4.3)	0.038	0.011	17.1	(—0.5)

The variable stars of spectrum M appear to be much like the general run of stars of this spectral class in distance, peculiar velocity and (at maximum) in brightness, being then about 100 times as bright as the sun. At minimum, the average long-period variable seems to be comparable with the sun in brightness.

Stars of Class B, showing bright hydrogen lines, do not differ materially in distance, brightness or peculiar velocity from those that do not, and stars of spectrum O are but little farther away or brighter.

The Cepheid variables, on the contrary, are very much farther away, brighter and more slowly moving than most stars of Classes F or G, and closely resemble the Orion stars in all these respects, and also in their strong condensation toward the Milky Way—so much so as to suggest some real relation between them. Even at minimum, these stars average some 400 times as bright as the sun. If they are comparable with it in surface brightness, as seems very probable, their diameters must be at least ten times the sun's—far larger than their spectroscopic orbits. If their average density was less than 1/1200 that of the sun, their companions would collide with them at periastron. It follows that the larger components of these systems must be more massive than the sun, and the invisible companions of the order of one tenth the mass of their primaries—as Campbell has anticipated.

The great brightness of all these variable stars seems a very serious objection to any theory which represents them as stars nearing extinction, but unfortunately, does not itself suggest any theory of their nature.

The Jupiter Perturbations of the Group of Small Planets, $\mu = 2/5$: D. T. Wilson.

Tables have been constructed by the Hansen-Bohlin method for the computation of the perturbations of Jupiter on the group of small planets whose mean daily motions are in the neighborhood of 750″. The perturbations of Pandora 55, of Bellona 28 and of Johanna 127 have been computed and the results compared with those of the same planets computed by Hansen's method by Messrs. Möller, Bohlin and Olsson.

Correcting and Testing Micrometer Screws: Wm. Gaertner.

Read by title.

The Temperature assigned by Langley to the Moon: Frank W. Very.

Langley's opinions in regard to the temperature of the lunar surface in sunshine varied widely at different times, but in the main he favored a low temperature.

The foundation of this opinion is examined and is shown to be invalid. Incidentally, statements by other investigators, which are based to some extent on Langley's opinion, are discussed.

The paper will be published in Science.

At the end of the last session a resolution was adopted expressing the thanks of the society to the authorities of Case School and other friends in Cleveland for the hospitality and privileges extended to the members of the Society.

Philip Fox,
Secretary

SCIENCE

FRIDAY, MAY 2, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE COLLEGE PRESIDENCY

THE only qualification I have for discussing the college presidency is the extraordinary opportunity I have had for studying colleges at first hand. During the past three years I have visited one hundred and five of the institutions listed in the reports of the United States Commissioner of Education as universities and colleges. These one hundred and five institutions are in twenty-nine states.

The main object of my travels has been to learn what I could about higher education in the United States; and, for various reasons, I have learned much from the inside. I have been a guest of the household. Trustees and faculty, students and citizens, have appeared glad to find a member of their profession, from afar, upon whom they could unburden themselves with fair assurance that the confidence would not be violated. I trust that I can be sufficiently concrete in discussing the college presidency without proving myself an ungracious guest.

Of the one hundred and five colleges and universities that I have visited I have become sufficiently acquainted with possibly fifty-one to form judgments concerning the success of their presidents in meeting the expectations of those whom they served. In other words, I believe that, in fifty-one cases, I have uncovered the sentiment of teachers, students and graduates with respect to their presidents. In the other cases, I have not collected adequate evidence for a valid generalization; either the testimony has been meager, or, though abundant, it has not pointed unmistakably in one direction. In these cases the presi-

dents may or may not be satisfactory to their constituents. I do not know.

Of the fifty-one presidents, thirty-four appear to be unsatisfactory. I mean that a majority of the faculty, students and alumni of thirty-four institutions *appear* to be in favor of a new president. In other words, if my observations are correct, two college presidents out of three are regarded as failures. If there is any error here due to the selection of institutions, it tends to make the proportion of failures too small, inasmuch as I purposely sought instances of satisfactory administration, colleges generally regarded as successful, those most likely to be attractive to men of power. Furthermore, had I taken a period of years, instead of one year, the proportion of failures would have been larger, since only those presidents who have survived are included in these figures. For example, one of the institutions, now in the successful list, had disposed of three unsatisfactory presidents in ten years.

On the other hand, it may be true that a man engaged in finding teachers for a new college was more likely to meet the disgruntled than the contented members of faculties. And it goes without saying that my judgment may have been false, even where the sentiment appeared to be almost unanimously in favor of or opposed to the retention of the president. It was not always so easy to get at the facts as it was in one college where the entire faculty, with one exception, had just petitioned the trustees for a new president. I dare say that certain complaining faculties, if sobered with the responsibility of an actual vote, would bear with their presidential troubles rather than fly to ills they knew not of.

Nevertheless, after these attempts to safeguard my conclusion against error, I am satisfied that a majority of college and university presidents in the United States have failed, on the whole, to perform, to the satisfaction of those most intimately concerned, the various duties now assigned to that office. If I were to class as failures those who had proved unequal to one or more of the obligations usually attached to the office, there would remain in the successful group scarcely a score. And who knows what reduction would appear in this small list if it were submitted for approval to a representative group of university leaders—let us say, to the American Association for the Advancement of Science?

With the chances of entire success in the college presidency two to one against the incumbent, it is a bold college professor who *seeks* the office. Possibly he has no adequate conception of the obligations involved.

What are those obligations? What do we expect of the American college president? From my observations, I am inclined to sum it up by saying that he must be all things to all men at all times and under all circumstances.

First of all he must be a scholar; he must have achieved distinction in a particular field, and he must continue to advance knowledge in that field. Otherwise he is not regarded as a respectable head for a so-called institution of higher learning, and comes to be regarded with contempt by certain scholars of the faculty. This means that he must have spent most of his life, before election to the presidency, in preparation for something other than the presidency; and, after election, he must spend much of his time, no matter how urgent his other duties may be, in work that has little to do with administration.

A second obligation is that of teaching.

It is urged with reason that the college president should be a good teacher and should continue to teach, in order that he may keep in close touch with the students and with the teaching problems of his faculty. The American college has been widely condemned in recent years because many of its classes have been entrusted to young persons who did not know how to teach and to scholars who did not care to teach. It is said that the college has neglected its function of teaching partly because the president and the classroom have been divorced.

It is said, with equal reason, that the college president should supervise the teaching. Expert supervision is regarded as absolutely necessary in every other branch of education, even though the means for training teachers, and the professional requirements of teachers, for all schools below the college are so much better than formerly. Yet the group which has the least preparation for teaching is the very group that teaches with the least supervision. At many a college, the president never appears in the classroom. If he is to be held responsible for the college as a teaching institution, and for the retention and promotion of men partly because of teaching ability, it is reasonable to expect him to supervise the teaching, until that duty is definitely assigned to another person. Supervision is, therefore, regarded by many persons as a third among the president's obligations.

A fourth duty of the president is business management. The increasing complexity of college affairs; the larger and more elaborate budgets; the development of new departments; the promotion of profitable relations with other institutions; the growth of the material equipment—buildings, laboratories, gardens, farms, museums, hospitals, dormitories, dining-halls, experiment stations, libraries, playgrounds;—all thrust upon the college executive obligations similar to those that exact the entire time and strength of the head of a commercial enterprise. If the business organization of the institution is to bring about and maintain the maximum economy and achievement, it demands the constant care of a man whose services in the open market are rewarded with several times the usual college president's salary. I know a man who was recently offered the presidency of a university at a salary of ten thousand dollars. He chose to retain his professorship at less than half that salary. He told me that if he were to give up his opportunities to study and write and teach in favor of a business career, he would accept—not the university presidency—but a previous offer to manage a commercial house at a much larger salary. As a matter of fact college presidents do delegate business matters to other officers; but, in nearly all instances, the ultimate responsibility, apart from the investment of funds, rests upon the president of a college, as it does upon the president of a railroad, or a bank, or a department store.

A fifth duty of the president—the raising of funds—is akin to the last; it is business, but a highly specialized form of business. It has no counterpart among the obligations that fall upon the head of an ordinary commercial establishment. No matter how well-endowed the institution may be, or how liberally supported by public taxation, the president is expected to increase its resources. Each alumnus applauds the effort—until the president reaches *him*. I have heard many of the faculty and graduates of a certain college flatly condemn their president—certainly among the ablest dozen college presidents in America—because they thought he had failed in this one part of his job, though

they admitted his notable success in every other part. In a few places, as at Oberlin, the increasing of the endowment has been made the business of a special officer; but in nearly all institutions the success of the president is measured to a considerable extent by his results in this specialized form of begging. If the institution is dependent on the periodic whims of legislatures, certain qualities are needed—those that make the expert lobbyist. If the institution is private, other qualities are needed. In either case, the man who is equal to the task could receive large rewards for his work in the domain of commerce—and be judged by his success in this one thing instead of a dozen.

But this is not all. The social obligations of the office—a sixth group of duties—are real and heavy, and they are becoming more exacting every year. Several men who a decade or two ago were regarded as admirable for the presidency of a certain university are now considered impossible because they *or their wives* are not socially notable, or because they have insufficient income for the extensive entertaining that now seems inseparable from the position. A man might be elected president of a railroad because of what he himself could do. Not so with the college president. He *and* his wife are elected. Some men disqualify themselves early in life by falling in love with a woman who could never become the social servant of a university.

It is part of the president's social duty to keep in close touch with the students, in order that he may contribute to their social education, and incidentally find out what is going on in the institution, to the end that he may wisely administer student affairs. The social duties also pertain to relations with alumni, for the president must seek opportunities of educating them, in order that they may help instead of hinder the progress of the university. The president is regarded by visitors from abroad as a social figure head, a public host, on duty the year round. But most important of all in the eyes of the trustees are the social obligations resplendent with the possibilities of influencing benefactors. There is no club or committee, no dinner or dance, no tea or reception, no convention or fair, no rally or round-up without its possibilities. The president and his wife could easily spend all their time and energy, and many times their salary, in social functions at their home and abroad, related in definite and promising ways to the satisfaction of the growing needs of the institution. Whatever one may think of all this as a concern of higher education, the social obligations of the president and his wife are real and heavy, and to a large extent, unavoidable.

In the seventh place, the president is called upon for every known form of public speaking. The idea prevails that he should be ready to speak at any time, on any subject, to any audience, anywhere; and some men apparently try to live up to the idea. He is expected to deliver eulogies over the bodies of prominent citizens and to make men merry with his after-dinner speeches; he is asked to address the chamber of commerce and the Browning Club; he is urged to harangue political mass meetings and to read poems at the dedication of Carnegie libraries; there are traditional obligations to preach sermons and conduct funerals; there are always the demands of teachers' conventions and alumni meetings, of women's clubs and legislative hearings, and others without number. What the next one may be he can not predict. Much of the proposed speaking he can avoid, but there is much that goes with the office. A man who could not speak in public might attain eminence as a physician, engineer, mer-

chant, architect, banker, scientist or playwright; a college president is sure to fail in much that is expected of him unless he is a public speaker of considerable power.

One of the essential qualifications of the college president I have left until the last; it is possibly the rarest and most important of all. He must get on with men and women, and somehow keep them working harmoniously and enthusiastically for the really important things in the life of the institution. He must needs be a spiritual force.

This power of leadership is made up of many elements. The first and last is patience. Another is a catholic interest and sympathy that enables him quickly to get the viewpoint of other men. Another is primary devotion to things bigger than himself, for a self-seeking man can not retain leadership in a college community. Another is a sense of his own limitations, for conceit repels. Conceit, however, is not likely to survive long after one attempts all that is expected of him as a college president.

Consider this necessity for getting on with men, retaining their confidence and loyalty, yet yielding no principle. He must command the support of trustees for policies they do not understand; he must deal justly with both factions of a faculty to the probable satisfaction of neither; he must keep the faculty happy without the desired salaries, staff and appropriations; he must deny the students what seem to them the chief desires of their hearts; he must send boys home and tell their parents that they are not equal to other men's children; he must defer the ambitious projects of citizens, in devotion to ideals the city can not share; he must use the alumni in making changes which the alumni naturally oppose; he must bring benefactors close to the college, while denying them the privilege of controlling it; he must attack tradition among worshipers of tradition; he must face opposition whether he performs or fails to perform any particular act; he must spend more time than he has, in explaining his conduct, or be condemned for not explaining. All these, and many more, are among the obligations of the presidency.

The question what *should* be expected of a college president I have not ventured to discuss. I have confined myself to conditions as I have found them in one hundred of our better institutions. I now venture to suggest that the trouble is not chiefly with the men, but with the post. Trustees do not, as a rule, select the least competent persons available; but they offer to men who have proved competent within a reasonable scope an almost impossible array of tasks. There are five hundred college presidencies, and not enough men to go around, as the office has evolved in the United States. There is something in the remark that a college president is "neither fish, nor flesh, nor good red herring." And there is something more than humor in the charge that a college president is, "*ex-officio,* a liar and a coward." A person in public office, attempting the impossible, is liable to every kind of criticism.

I venture the further suggestion that the remedy is not to curb the power of the president, while continuing to expect too much; it will not help matters to encumber executive action with complications and delays, while leaving upon the office more duties than a man could meet even with the power of a despot. The college president is already regarded as a poor risk by life insurance companies.

It may be best to assign certain of the functions enumerated above to other officers. The duty of spiritual leadership, historically the most important of the functions of the college president in America,

has now been delegated in many places to a chaplain or a board of preachers. But the change has not been applauded always by those who believe in moral and religious education. The increase of endowment and equipment may be assigned to a special officer, but the president is, *ex-officio,* more likely to influence prospective benefactors. So, also, with social obligations, they attach to the office; they can not be transferred to another person, by executive action or by vote, like the advertising department of a soap factory. The president can easily turn over to others all the privileges of the scholar, the supervisor and the teacher; but the fact that he has done so is one of the present charges against him. Furthermore, he is loath to resign these privileges, if he has any capacity for intellectual leadership. Finally, the president might be relieved of business management—that branch of affairs which has always been most foreign to the dominant interests of great scholars and great teachers. But, as a matter of fact, I have found the most confusion and the unhappiest faculties in those institutions, of all that I have visited, where the authority in business matters has been vested in some person or persons other than the president. Nobody can possibly make a budget satisfactory to all concerned; but the one most likely to take successful leadership in budget-making is the one most intimately and sympathetically in touch with every aspect of the life of the university. That person, under present conditions, is the president. His other duties are so intricately involved with business affairs, that it seems unreasonable to withhold control in this domain while holding him responsible in others.

In short, the principle of centralization of responsibility and adequate authority, which is well established in all public school affairs, must be reckoned with in all new plans for university control. Something should be done by way of reorganization or definition, to the end that a college may have more than one chance in three of obtaining a successful president. But whatever is done should be based on this principle of centralization of responsibility with adequate authority, and on the scope and the difficulties of the president's obligations.

The discussion of faculty control carried on in SCIENCE, and elsewhere, is much to the point. It should lead presidents to clearer ideas of their short-comings and professors to a more sympathetic understanding of the causes. It should lead to greater faculty control through officers elected by the faculty for short terms, and to faculty representation at stated meetings of the trustees. It should lead to a fixed plan for salaries in each institution, that would go a long way toward reducing the proportion of failures among presidents. Finally, I believe this whole discussion should bring us to some consideration of the fact that preparation for the office of president, in spite of the excessive demands upon the office, is left largely to chance. So far as I know, there is not even a course in higher education given in any college or university in America. Nor is there such an opportunity as a Kahn traveling fellowship might provide for prospective presidents. When we consider the administration of higher education of sufficient importance, we shall make provision for trained leadership. Meantime, let us all be charitable,—trustees, presidents, professors, graduates, students; our faults are many, and which of us is without them?

WILLIAM T. FOSTER

REED COLLEGE,
PORTLAND, ORE.

THE IMPERIAL BUREAU OF ENTOMOLOGY

As the question of international effort and cooperation in the matter of controlling and preventing the spread of insects which in various ways affect human activity is occupying the attention, not only of entomologists, sanitarians and workers directly occupied in studying these many-sided problems, but also of statesmen and administrators, the formation in connection with the British Imperial service of an Imperial Bureau of Entomology at the beginning of the present year will undoubtedly interest all concerned in these problems, by whom its progress and work will be watched.

This organization is not a sudden development but a gradual outgrowth of efforts along similar lines which began in the spring of 1909. In March of that year a meeting was called by the secretary of state for the colonies at the colonial office in London, in which the present writer had the honor to take part, to discuss the formation of an entomological research committee for the purpose of furthering entomological research in the British possessions in tropical and subtropical Africa. The chief insects which it was considered desirable to study were those associated with the transmission of disease. In 1909 an entomological research committee of the colonial office was appointed by Lord Crewe, then secretary of state for the colonies, and it consisted of the chief experts in entomology and tropical medicine in Great Britain and Ireland, with Lord Cromer as chairman. Its work fell under three divisions, namely, the carrying on of investigations and entomological surveys in tropical Africa, for the purpose of which two traveling entomologists were employed; the determination of entomological material, and the publication of the work so accomplished, for which purpose the *Bulletin of Entomological Research*, a quarterly journal, was started. Through the generosity of Mr. Andrew Carnegie, the committee was able also to undertake the training of a number of entomologists for service in the dominions and colonies.

On account of the valuable service which was being rendered by the committee to the African crown colonies and protectorates, suggestions were made for the enlargement of the scope of the work of the committee. Accordingly, in June, 1911, advantage was taken of the presence in England of the prime ministers of the self-governing dominions and a conference was called by the secretary of state for the colonies to consider the desirability of further extending the work already begun by securing the cooperation and financial support of the self-governing dominions and colonies. By these means mutual assistance could be rendered by the various countries within the British Empire through the medium of a central bureau which would be engaged in the collection and interchange of information in regard to noxious insects. It was unanimously agreed that the establishment of such a central bureau was desirable, as it was realized what valuable assistance it could render in the way of disseminating information and rendering assistance in other ways. Accordingly, a tentative scheme was submitted to the governments of the various self-governing dominions and colonies for their consideration.

After due consideration and consultation a further conference was held at the colonial office in August, 1912, to which the government entomologists of the self-governing dominions and colonies and others similarly interested were invited, to discuss and work out a scheme for imperial cooperation in preventing the spread and furthering the investigation of noxious insects. At this conference the whole subject was thoroughly discussed and a proposal was evolved for the establishment of an imperial bureau of entomology to be financially supported by the various dominions and colonies and the British government.

It was proposed that the functions of the Imperial Bureau of Entomology should be as follows:

1. A general survey of the noxious insects of the world and the collection and coordination of information relating thereto, so that any British country may learn by enquiry

what insect pests it is likely to import from other countries and the best methods of preventing their introduction and spread.

2. The authoritative identification of insects of economic importance submitted by the officials of the Departments of Agriculture of Public Health throughout the empire.

3. The publication of a monthly journal giving concise and useful summaries of all the current literature which has a practical bearing on the investigation and control of noxious insects.

The scheme was accepted by the various self-governing dominions and colonies which were invited to cooperate, and the crown-colonies and British protectorates will also participate in the advantages of the Imperial Bureau of Entomology which has now been established. The former entomological research committee has become the honorary committee of management with the eminent administrator, the Earl of Cromer, as president and the scientific secretary of the committee, Mr. Guy A. K. Marshall, has been made director of the bureau and editor of the journal. The government entomologists of the dominions are *ex-officio* members of the committee of management.

The publication of the bureau's journal, which is entitled *The Review of Applied Entomology*, was commenced in January. It is being published in two parts: Series *A*, Agricultural, and Series *B*, Medical and Veterinary. As the organization and library of the bureau becomes perfected the value of this journal to entomological workers can not be overestimated, when it is remembered that there are no less than 1,700 periodicals, scientific, agricultural and medical, which may contain articles dealing with entomology, but a small proportion of which widely scattered entomologists have the opportunity of seeing or the time to consult.

An idea of one aspect of the three years work of the original entomological research committee will be gathered from the fact that the collections received from collecters in tropical Africa and other parts of the world during that time amounted to about 190,000 insects, of which no less than 56,000 were actual or potential disease carriers. The value of this function of the Bureau to entomologists situated in portions of the empire where there are no collections and little literature to aid in identification work will be realized by their more fortunate fellow-workers.

It has been stated in the press that the Imperial Bureau of Entomology will serve the needs of the British Empire in a manner similar to that in which the United States Bureau of Entomology serves those of the United States. This statement, however, is not correct. Its primary function will be that of an intelligence bureau, collecting information for the use of the British countries supporting it and assisting entomologists and other officials in those countries in the identification of their material. By the methods which have been mentioned, and by the publication of *The Review of Applied Entomology*, and of *The Bulletin of Entomological Research*, it will furnish a means of assistance and of coordination of effort in the war against noxious insects which will undoubtedly soon make its services invaluable in the further development of the countries of the British Empire. International as the scope of its inquiries are, the work of the Bureau can not but prove to be one of the most potent factors in enabling us to develop the agricultural and other resources of the empire and our fellow-workers in non-British countries can avail themselves, through its journal, of some of the fruits of the Bureau's work.

C. GORDON HEWITT,
Dominion Entomologist

OTTAWA, CANADA,
March, 1913

THE COMMITTEE ON THE PACIFIC COAST MEETING OF THE AMERICAN ASSOCIATION

THE committee on the Pacific Coast meeting of the American Association held its first meeting at the University of California on April 12, 1913, with Director Campbell in the chair. About twenty members were pres-

ent. The following resolution was unanimouly adopted:

This committee, on behalf of the western members of the American Association for the Advancement of Science, expresses its gratification at the proposal to hold a meeting on the Pacific Coast during the summer of the year 1915, and hereby extends a cordial invitation to the association and to all its affiliated societies to meet in San Francisco at the time of the Panama Exposition.

Sub-committees and their chairmen were appointed as follows: Time and place of meeting, A. C. Lawson; transportation, H. S. Ryan; hotels and accommodations, A. L. Kroeber; program, G. E. Hale; excursions, A. G. McAdie; reception and entertainment of visiting ladies, Agnes Claypole Moody; membership, Vernon L. Kellogg; publicity, J. C. Merriam; finance, D. T. MacDougal; executive committee, W. W. Campbell. An honorary local committee of one hundred will also be appointed.

The question of the organization of the Pacific Coast members into a geographical division with power to hold meetings and present scientific programs was discussed at length. A motion that it be the sense of the committee that such a division should be established was unanimously carried; but it was the general feeling that the success of such a step would depend upon the attitude of the Pacific Association of Scientific Societies. It is to be hoped that this association will merge itself into the Pacific Coast Division of the American Association and its constituent societies become affiliated with the latter. The executive committee was asked to consider the whole matter and to endeavor to secure the cooperation of the various scientific societies on the Pacific Slope.

The affiliation of these societies and an active campaign for membership would undoubtedly greatly increase the membership of the association on the Pacific Coast. This, together with the attractive features of the exposition and the varied natural beauties of the Pacific slope, should cause a very large attendance at the meeting in 1915.

E. P. Lewis,
Secretary

MINUTES OF THE COUNCIL OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The council of the association met at the Cosmos Club, Washington, on Tuesday, April 22, 1913, at 5 P.M. Those present were: Messrs. Wilson, Alsberg, Bessey, Boas, Cattell, Campbell, Diller, Humphreys, Kober, MacBride, MacDougal, Nichols, Pickering, Woodward and Howard.

The permanent secretary read nominations made by the sectional committee of Section K for Dr. Theodore Hough, as vice-president and chairman, and Dr. John R. Murlin, as secretary. On motion, these were elected.

On motion, Mr. Seymour C. Loomis was made a fellow of the association.

Mr. Cattell submitted the report of the committee on policy, and, on motion, the following resolutions recommended by the committee were adopted:

Resolved, That the Pacific Coast committee be authorized to secure an associate secretary for the Pacific Coast at a salary of one hundred dollars a month, this officer to devote at least one half of his working time on the work of the Pacific Coast committee in the effort to advance the interests and increase the membership of the association under the direction of the Pacific Coast committee, and, further, that an appropriation of six hundred dollars, or so much thereof as may be necessary, be made for paying the office and traveling expenses of such secretary.

Resolved, That a committee consisting of Messrs. J. A. Holmes, W. J. Humphreys, H. M. Smith and the permanent secretary, be authorized in the early autumn to select and appoint a temporary associate secretary for the south at a salary of two hundred dollars a month, for not more than four months, with two hundred dollars in addition for traveling and office expenses, whose duties shall be to advance the interests and increase the membership of the association in the south, with an especial effort to increase the interest in, and the attendance at, the Atlanta meeting.

On motion, the recommendation that Dr. Carl L. Alsberg be elected vice-president and chairman of Section C was adopted.

On motion, Dr. Walter B. Pillsbury was made a fellow of the association, followed by the adoption of a motion that he be elected vice-president and chairman of Section H.

On motion, Mr. Judson G. Wall was made a fellow of the association, followed by the adoption of a motion that he be elected vice-president and chairman of Section I.

The following resolutions recommended by the committee on policy were adopted:

Resolved, That the Pacific Coast committee be authorized, in the absence of constitutional authority, to designate its meetings at which scientific programs are presented as "Meetings of the Pacific Coast Division of the American Association for the Advancement of Science."

Resolved, That the Pacific Coast committee be placed in charge of all arrangements, including program, for the proposed Pacific Coast meetings in 1915 in cooperation with the several sectional secretaries and in consultation with the permanent secretary.

The following preamble and resolution recommended by the committee on policy was adopted:

WHEREAS, It is eminently desirable that scientific men especially skilled in their departments be appointed as heads of the scientific bureaus of the government, therefore,

Resolved, That a committee of three be appointed to communicate to the President of the United States that it is the opinion of the council of the American Association for the Advancement of Science that a scientific man skilled in meteorology should be selected as the Chief of the Weather Bureau.

The following resolution recommended by the committee on policy was adopted:

Resolved, That the president be authorized, with the advice of the committee on policy, to appoint a Committee of One Hundred on Scientific Research under the government, in the universities and in other institutions.

On motion, it was

Resolved, That the council allow the sectional committee of Section C to nominate and elect the new secretary of that section.

On motion, it was

Resolved, That the council delegate full powers to the committee on policy with respect to all arrangements concerning the organization of the Pacific Coast Division of the association, including all matters relating to the affiliation of the individual societies composing the present Pacific Association of Scientific Societies.

At 6.10 P.M., the council adjourned.

L. O. HOWARD,
Permanent Secretary

THE ANNIVERSARY MEETING OF THE NATIONAL ACADEMY OF SCIENCES

THE National Academy of Sciences celebrated the semi-centennial anniversary of its foundation on April 22, 23 and 24, exactly fifty years after its first meeting. It was a most successful meeting with the largest attendance of members in the history of the academy. There was no program of technical papers, but in its place a series of addresses. Dr. Ira Remsen, the president of the academy, at the first session read an address on the history of the academy, and then introduced President Arthur T. Hadley, of Yale University, who spoke on "The Relation of Science to Higher Education in America." He was followed by Dr. Arthur Schuster, secretary of the Royal Society of London, who spoke on "International Cooperation in Research." At the afternoon session Dr. George E. Hale, director of the Mt. Wilson Solar Observatory, gave an address on "The Earth and Sun as Magnets." On the morning of the following day, Dr. J. C. Kapteyn, director of the Astronomical laboratory of the University of Groningen, gave an address on "The Structure of the Universe." Dr. Theodor H. Boveri, of the University of Würzburg, was to have spoken on "The Material Basis of Heredity," but was unable to be present owing to ill health.

The program left ample time for social events, which were admirably arranged. Luncheons were provided each day and there were evening receptions at the National Museum and the Carnegie Institution. The afternoon of April 24 was devoted to an excursion to Mt. Vernon on the U. S. S. *Mayflower*. On the afternoon of April 23, there was a reception at the White House, when the President of the United States conferred medals, and afterwards, with Mrs. Wilson,

received and entertained the members of the academy and their guests. The Watson medal for astronomical research was presented to Dr. J. C. Kapteyn, the Draper medal for astrophysical research to the French Ambassador for M. Henri Deslandres, the Agassiz medal for oceanographical research to the Norwegian minister for Dr. Johan Hjört, and the Comstock prize of the value of $1,500 for research in radiant energy, to Professor R. A. Millikan, of the University of Chicago. At the dinner on the evening of April 24, Dr. R. S. Woodward acted as toastmaster and speeches were made by the vice-president of the United States, the British Ambassador, Dr. S. Wier Mitchell, Dr. W. W. Keen, president of the American Philosophical Society, and Senator Burton.

At the business meeting of the academy the following new members were elected: Henry Andrews Bumstead, professor of physics, Yale University; L. E. Dickson, professor of mathematics, University of Chicago; Ross G. Harrison, professor of comparative anatomy, Yale University; Gilbert Newton Lewis, professor of physical chemistry, University of California; Lafayette B. Mendel, professor of physiological chemistry, Yale University; George H. Parker, professor of zoology, Harvard University; L. V. Pirsson, professor of geology, Yale University; Edward B. Rosa, chief physicist, Bureau of Standards; Erwin F. Smith, pathologist in charge, Bureau of Plant Industry, U. S. Department of Agriculture; A. O. Leuschner, professor of astronomy, University of California.

The officers elected for a term of six years were:

President—Dr. W. H. Welch, professor of pathology, The Johns Hopkins University.

Vice-president—Dr. Charles D. Walcott, secretary of the Smithsonian Institution.

Home Secretary—Dr. A. L. Day, director of the Geophysical Laboratory of the Carnegie Institution.

SCIENTIFIC NOTES AND NEWS

Sir William Osler, regius professor of medicine, gave, last week, the Silliman lectures at Yale University. The subject of the course was "The Evolution of Modern Medicine."

The Walker grand honorary prize, which is awarded by the Boston Society of Natural History once in five years, was this year voted to Mr. Robert Ridgway, of the United States National Museum, in recognition of his investigations in ornithology, and particularly for his work on the "Birds of North and Middle America." This prize, the amount of which is one thousand dollars, was founded by the late William Johnson Walker, a benefactor of the society, and is given in recognition of important investigation in natural history, published and made known in the United States of America.

President Richard C. Maclaurin, of the Massachusetts Institute of Technology, has taken out the first papers for citizenship in the United States. His statement shows that he was born in Scotland, forty-six years ago, and that his last foreign place of residence was New Zealand.

Dr. R. S. Breed, for several years professor of biology at Alleghany College, has been selected as bacteriologist of the New York Agricultural Experiment Station, Geneva, N. Y. Dr. Breed succeeds Dr. H. A. Harding who becomes head of the dairy department of the University of Illinois. Dr. Breed is a graduate of Amherst and of Harvard, having a Ph.D. from the latter institution. He will assume the duties of this position about August first.

Dr. Maurice C. Tanquary, instructor in zöology in the Kansas State Agricultural College, has been granted a three years' leave of absence in order that he may accompany the American Museum of Natural History Crocker Land Expedition.

Dr. A. Hrdlicka, of the U. S. National Museum, has returned from his expedition to Peru. He has secured important collections in physical anthropology and pre-Columbian pathology.

Dr. Frank K. Cameron, of the U. S. Bureau of Soils, visited the Pacific coast during April in the interests of the fertilizer investigation. In Seattle he delivered before the local society of Sigma Xi an address on "A Dynamic View of Soil Fertility." He was accompanied on the trip by Dr. J. W. Turrentine, who will remain on the coast during the summer, investigating fertilizer resources.

Professor William Herbert Hobbs, who has been abroad on leave of absence since June, 1912, has now returned to the University of Michigan. In the summer of 1912 Dr. Hobbs carried out tectonic and glacial studies in the Swiss and French Alps, and in the following winter visited the deserts of Egypt and the Soudan.

Dr. N. L. Britton and Dr. J. N. Rose, who left New York City on January 25, for the purpose of making a special study of the Cactaceæ of the West Indies have returned. Although they went especially in the interest of the cactus investigation of the Carnegie Institution of Washington, yet a general botanical survey was made, and they have brought back a very large collection of living plants and about 13,000 herbarium specimens. They went first to St. Thomas, where the party was divided. Dr. and Mrs. Britton, Dr. J. A. Shafer and Miss Delia W. Marble, explored the Virgin Islands, Porto Rico and Curaçao, while Dr. Rose, accompanied by Wm. R. Fitch and Paul G. Russell, visited St. Croix, St. Kitts and Antigua, and, after returning to St. Thomas, made extensive collections in Santo Domingo along the southern side and eastern end of the island.

Henry H. Norris, professor of electrical engineering in Cornell University and secretary of the Society for the Promotion of Engineering Education, is devoting a leave of absence to a special investigation for the McGraw-Hill Book Company of engineering books in all fields. He will cover both college text-books and general reference books. His work is practically a scientific investigation of these texts. On the basis of this investigation and the suggestions which Professor Norris will collect, a broad series of new books will be planned and undertaken for all fields of engineering, with a view to a new and more useful technical literature.

The following lectures have been arranged by the department of chemistry of the College of the City of New York:

April 11—Professor Alexander Smith, professor of chemistry and director of the laboratory, Columbia University: "Forms of Sulphur and their Relations."

April 25—Dr. Charles F. McKenna, past president Institute of Chemical Engineers: "Chemical Engineering, Present and Future."

May 9—Mr. A. D. Little, president American Chemical Society: "Manufacture of Wood Pulp and Paper."

May 23—Dr. M. W. Franklin, General Electric Co.: "Ozone."

George C. Whipple, professor of sanitary engineering at Harvard University, is giving a course of lectures on "Applications of Water Analysis" at the Polytechnic Institute of Brooklyn.

Dr. Theobold Smith, of Harvard University, delivered an address to the Pathological Society of Philadelphia, April 24, on "An Attempt to Interpret Present-day Uses of Vaccines."

On April 7 Dr. D. T. MacDougal, of the Carnegie Desert Laboratory, lectured before the Southern California Academy of Sciences in Los Angeles, on "Some Physical and Biological Problems of American Deserts."

The life and services of Dr. John Shaw Billings, late director of the New York Public Library, who died on March 11, were commemorated, before a notable gathering in the Stuart gallery of the Public Library on April 26. Mr. John L. Cadwalader, president of the New York Public Library, presided, and first introduced Dr. S. Weir Mitchell, as one of Dr. Billings's oldest and closest friends, who told of the arduous services rendered by him in his early years in the civil war. Sir William Osler described his great contribution to bibliography. Dr. William H. Welch paid

tribute in behalf of the trustees of Johns Hopkins Medical School and the medical profession to the services of Dr. Billings as a hospital organizer. Mr. Andrew Carnegie spoke of his associations with him in library work and in the organization and conduct of the Carnegie Institution of Washington. Mr. R. R. Bowker presented the tribute and homage of the library profession to the memory of Dr. Billings and his work.

AT the meeting of the Johns Hopkins Hospital Historical Club on April 14, Dr. Fielding H. Garrison presented to the medical school a portrait of the late Dr. Robert Fletcher, of the Surgeon-General's Library, Washington, D. C.

DR. ANDREW SLOAN DRAPER, New York state commissioner of education, and former president of the University of Illinois, died at Albany on April 27, aged sixty-four years.

ON April 10 the Brooklyn Botanic Garden began the publication of four-page *Leaflets*. The purpose of the *Leaflets* is twofold: "first, to give announcements concerning flowering, and other plant activities to be seen in the garden at the time the leaflet is issued; second, to give popular, elementary information about plant life, primarily for teachers, or for others who may wish to learn something about plants besides merely their names." Some of the numbers will aim to give, in simple, nontechnical language, the subject-matter for a nature study lesson, which may be conducted by the teacher, in the garden or elsewhere. The *Leaflets*, which for the present are issued weekly or bi-weekly during April, May, June, September and October, will be mailed free to those who are interested.

AT the closing session of the International Geographical Congress, on April 3, it was agreed that the next congress should be held at St. Petersburg.

THE wireless telegraphy station of the Ohio State University did excellent service during the recent flood. When communication by telephone and surface telegraph with other cities was cut off, the wireless became the only means of reaching the outside world. Messages were sent to Cleveland and the University of Michigan and relayed from those stations by wire to their destination.

THE ninth annual meeting of the Prehistoric Congress of France will be held at Lons-le-Saunier from July 27 to August 2, 1913.

THE forty-fourth annual meeting of the German Anthropological Society will be held at Nurnberg from August 8 to 9, 1913.

AT the eighty-sixth convocation of the University of Chicago, held on March 18, announcement was made of the election of thirty-five students as members of Sigma Xi for evidence of ability in research work in science. Six of these were women.

WE learn from the British *Geographical Journal* that news has been received in Holland from an official source that Mount Carstensz, the highest known summit of the snowy range of western New Guinea, has been successfully ascended by Dr. A. F. R. Wollaston, accompanied by Lieutenant van de Water, of the Dutch army. This, it will be remembered, was the chief task which Dr. Wollaston (who had taken a leading part in the previous expedition to Dutch New Guinea, organized by the British Ornithologists' Union) had set himself when undertaking his new expedition, and he is to be congratulated on successfully accomplishing his object. The height of the peak has been variously estimated, being thought for a time to reach an altitude approaching 18,000 feet. Recent surveys, however, especially those of the previous British expedition, had given reason for reducing the height to something under 16,000 feet.

A DEPUTATION from the Eugenic Education Conference recently held in London had an interview with Mr. Trevelyan, parliamentary secretary to the Board of Education, on April 2, asking that an inquiry should be held as to the advisability of encouraging the presentation of the idea of racial responsibility to students in training and children at school. The deputation, which was headed by Major L. Darwin, president of the Eugenics Education Society, stated that it was not desired that eugenics should be an extra subject in

the curriculum, or that it should be required to be taught by unwilling teachers, but it urged that the training college curriculum should be adapted to include the biological and physiological knowledge on which a eugenic ideal could be based, and that the subject should be approached from the evolutionary standpoint. Mr. Trevelyan said that the board, while unable to make sex hygiene or eugenics a compulsory subject of instruction in elementary schools or training colleges, recognized the importance of the matter, and had no wish to discourage experiments in teaching on those lines.

It is stated in the *Electrical World* that several pieces of electrical apparatus constructed by Volta during his early electrical experiments were discovered recently by Sir Henry Norman, a member of the British parliament, in a little curiosity shop in an out-of-the-way section of a small Italian town. The uncle of the shopkeeper was Volta's cook and body servant for thirty years. On his death he left much of his experimental apparatus with this servant, and it has since passed down from generation to generation. The collection comprises a cupboard full of old apparatus, a number of books, portraits, papers and letters and some personal and domestic articles. Sir Henry Norman suggests that the collection be purchased and presented to the Royal Institution to be placed with Faraday's original apparatus.

UNIVERSITY AND EDUCATIONAL NEWS

The will of the late Isaac M. Jackson, of Plymouth, Mass., among other public bequests, gives $15,000 to Yale University.

It is reported that the medical department of Willamette University, Salem, has been merged with the medical department of the University of Oregon, located at Portland, the merger to take effect at the conclusion of the present college year. There will hereafter be but one medical college in the state. A biennial appropriation of $45,000 has been made by the Oregon legislature for the medical department of the state university.

The development of a health instruction bureau in connection with the Extension Division of the University of Wisconsin has been authorized by the regents. According to authorities in medicine, hygiene and vital statistics, the average duration of human life could be raised fifteen years if all the present available medical and hygienic knowledge were intelligently applied. The new health bureau will undertake to carry out to the people of Wisconsin this knowledge. Bulletins will be published on preventable diseases, infant mortality, hygiene and similar subjects. Public lectures, health institutes, etc., will also be given.

Professor Allyn A. Young, of Washington University, St. Louis, has been appointed professor of economics at Cornell University, to succeed Professor E. W. Kemmerer, now of Princeton University.

DISCUSSION AND CORRESPONDENCE

A METHOD FOR MAKING PARAFFIN BOTTLES FOR HYDROFLUORIC ACID

The usual method of making containers for hydrofluoric acid for use in softening hard woody tissue is, either to use the large wax bottles in which the acid comes from the dealer, or ordinary glass bottles which have previously been coated on the inside with paraffin. Owing to the size of the bottles the first of these methods is inconvenient, unless a large number of blocks of wood are to be softened at one time, and the second method is often unsatisfactory, as the paraffin sometimes cracks, allowing the acid to eat through the glass. These difficulties led me to devise the following bottle which is easy to make and is more satisfactory in its operation than the above.

Ordinary cardboard mailing tubes, of the proper diameter, should be cut into lengths of about ten centimeters each. These should be thoroughly infiltrated by placing them in a vessel of melted paraffin and leaving them in the oven for a short time. After the cardboard has become infiltrated the tubes should be removed, and when the paraffin has hard-

ened, they should be set on end on a cool moist surface and enough melted paraffin poured in to form a bottom four or five millimeters in thickness in each of the bottles. After cooling, each bottle should be filled with melted paraffin and emptied, a process that should be repeated every few minutes until a rather thick coating has formed on the inside. The exterior should be treated in a similar way by dipping the bottles into melted paraffin.

Rubber stoppers can be fitted to these bottles by warming the neck of each and by pressing a stopper, of the proper size, into the opening before the paraffin cools. If rubber stoppers are not available, ordinary bottle-corks, which have been coated with paraffin, can be used with quite as good results.

ALBAN STEWART
UNIVERSITY OF WISCONSIN

NOTES ON CUBAN FRESH-WATER FISHES

WHILE collecting fossils in the province of Santa Clara, Cuba, in 1911, my work took me to Baños de Ciego, Montero, 30 miles north of Cienfuegos. Here occur three hot springs having a temperature, respectively, of 93, 96 and 99 degrees Fahrenheit. These springs are grouped close together, not more than 20 yards apart and about 200 yards from the Analla River into which they drain. The springs of 93 and 96 degrees temperature are walled in and the latter is surrounded by a hotel. The one of 99 degrees temperature is of largest volume and has direct communication with the river. In this spring as well as in the drainage water of the other springs and the cold water of the river, I found a great many fishes, mostly viviparous.

The following species have been identified from the spring:

Symbranchus marmoratus Bloch.
Gambusia puncticulata Poey.
Glaridichthys falcatus Eigenmann.
Girardinus metallicus Poey.
Pœcilia vittata Guichenot.
Heros tetracanthus (Cuv. & Val.).

Of these the eel-like *Symbranchus marmoratus* was found only in the hot spring. The other species, so far as I was able to observe, were common to both the cold water of the river and that of the hot springs, becoming acclimated by degrees, until they were finally able to live in the hottest water, 37° Centigrade, approximately that of blood temperature.

I was curious to know if it were possible for these fishes to live equally well in the hot spring water of 99 degrees temperature and the river water of 60 degrees temperature without first going through a process of acclimization, so conducted a number of experiments. It was quite evident that fishes could gradually come from the cold water into that of the hottest temperature, so I took a number from the hot spring, carefully catching them in a net so as to avoid injury and placed some in river water and others in water from the other springs. Those placed in water of 93 degrees temperature seemed to live in it as well as in that of 99 degrees, but those placed in river water, out of eleven fishes, nine died within ten minutes. The other two lived.

This experiment was repeated several times with similar results; more than two thirds failing to resist the sudden change of temperature.

I am unable to tell whether those used in the experiments were *Gambusia puncticulata*, *Glaridichthys falcatus*, *Girardinus metallicus* or *Pœcilia vittata*, but probably they were mostly the latter genus and species, as this form was most abundant in the Chapapote spring.

While living in the hotel during a heavy storm the Analla River overflowed, sending a branch across this Chapapote spring. The following day we pumped out the water, finding a great many viviparous fishes, probably all of the four determined small species and a number of viajecos, *Heros tetracanthus*. Evidently they had all become acclimated to the hot water during the time of this overflow.

Besides the species mentioned, the collection contains two species which were not found in the warm spring, *Gambusia punctata* Poey, of which two were obtained from the Rio Analla and several from a tributary of the Zaza, and

Glaridichthys torralbasi Eigenmann, represented by one specimen from the latter locality.

BARNUM BROWN

SCIENTIFIC BOOKS

A History of Geographical Discovery in the Seventeenth and Eighteenth Centuries. By EDWARD HEAWOOD, M.A. Small 8vo. 475 pages. Cambridge University Press.

This work is one of the Cambridge Geographical series, its author being librarian to the Royal Geographical Society. Its aim is to deal with the less known period which followed the great discoveries of the fifteenth and sixteenth centuries. The author defines his period as "that in which, after the decline of Spain and Portugal, the main outlines of the world-map were completed by their successors among the nations of Europe." The book is therefore a narrative mainly of the explorations of Great Britain, Netherlands, France and Russia. The sphere of the French was largely in North America, and Russian endeavor was devoted to northern Asia and its adjoining seas, while it was left to the English and Dutch navigators to fill in the map of the remote seas and distant lands of the globe.

At the close of the period the map of the world was distinctly modern, though it remained for the explorers of the nineteenth and twentieth centuries to fill in most of the map of Africa and of the polar regions, and to make more advanced surveys and detailed study of all lands and seas.

The author is hampered by the necessity of crowding a vast amount of material into a small volume, which is an encyclopedia in outline, and hence lacks continuity, and interest for the general reader. Hundreds of localities and explorers are noticed, each in a sentence or two, with the barest statement of what the explorer did, or tried to do. But this is probably the fault of the series as planned, and not of the author. In a few instances he has given a relatively full and keenly interesting narrative, as, for example, of Tasman, Anson, Hudson, Cook and Vancouver.

About sixty illustrations contribute substantially to the value and interest of the volume. These include many maps belonging to the period, and several portraits of the more eminent navigators. Considering its small size, about four hundred pages of text, the work is well suited for reference, particularly by reason of the thoroughness with which the index has been prepared. This occupies about fifty double-column pages and contains several thousand entries.

ALBERT PERRY BRIGHAM

Terminologie der Entwicklungsmechanik der Tiere und Pflanzen. In Verbindung mit Professor C. CORRENS, Professor ALFRED FISCHEL, Professor E. KUSTER von Professor WILHELM ROUX. Leipzig. 1912. Pp. xii + 465.

This book represents a type of purely scientific publication which has been scarcely attempted as yet in this country for any field of the biological sciences. As Professor Roux points out in the preface of the book, the development within recent years of analytic investigation in biology has brought about the development of a new terminology, especially in connection with embryology and inheritance. The purpose of this book is to make it possible to determine readily the meanings given to new terms by their authors, as well as the special meanings which many terms have acquired in connection with experimental and analytic investigation. That a real need for a book of this sort exists Professor Roux regards as evident because, as he says, the previously published terminologies of zoology, biology, medicine, etc., have for the most part omitted the special terminology of developmental mechanics.

The book defines some eleven hundred terms, purely philosophical terms being excluded and botanical and zoological terms being combined as far as seemed advisable. But that the book is far more than a simple dictionary will be evident from the fact that the eleven hundred terms occupy nearly five hundred pages. In many cases reference is made not

only to synonyms, but to related terms, and for most of the new terms which have appeared in connection with analytic work the author's name and the year, or in some cases the full bibliographic reference is given. In addition to this for many of the more important terms the subject-matter consists not simply of a definition, but of a short article of cyclopedic character. For example, under "Correlation" there are two pages of definitions, analysis, references, etc., under "Erbformel" one page, under "Experiment" almost five pages, under "Faktor" two pages, under "Heteromorphose" more than two pages. "Potenz" has nearly two pages, "Regeneration" nearly three pages, "Reiz" with compounds and adjective terms six pages, "Vererbung" five pages, etc. Each definition or article is signed with the initial of its writer.

Many terms consisting of substantive and adjective and a considerable number which consist of several words are included, *e. g.*, "adventive Bildungen" "erbgleiche Bastarde," "funktionelle Hypertrophie," "ontogenetisches Causalgesetz," "correlative Variabilität," "Gesetz der Concordanz der Zellteilung," "Lage der Teile im Ei und Embryo," "Lysintheorie der Entwicklungserregung." The alphabetic arrangement of such terms in the book does not follow any invariable rule, but is determined by the most characteristic word.

Every student of "developmental mechanics" is familiar with Professor Roux's pioneer work in the development of an analytic terminology as well as in analytic investigation, and it is of course to be expected that no inconsiderable portion of the book is devoted to the terms of which he is the author.

In general the book has a distinctly morphological cast, as might be expected from its title and its authors, but a considerable number of strictly physiological and some physical and chemical terms are briefly defined. It seems possible that in an eventual second edition some expansion along these lines may perhaps be desirable.

The following quotation from the preface suggests how the book may be used not merely for reference, but as an introduction to the subject:

> Wer diese Terminologie zu seiner E i n f ü h r u n g i n d i e E n t w i c k l u n g s m e c h a n i k verwenden will, dem ist zu empfehlen, der Reihe nach mit der Lektüre der Artikel: Entwicklung, Entwicklungsmechanik, Analyse, Differenzierung, Faktoren, Determination, Autoergie, Potenz, Lebewesen, Funktionen, Wachstum, Anpassung, Perioden, Experiment zu beginnen und die in jedem Artikel befindlichen Verweisungen zu benutzen.

The publishers, the firm of Wilhelm Engelmann in Leipzig, have done their part in the manner to be expected of them: the book is convenient in form and size, the type is sufficiently large for perfect ease in reading and the typographic work is of the highest grade. In a rather extended examination of the book the reviewer has not noted a single typographical error.

There can be no doubt of the value of the book. It should be of great assistance to clearness of thought and expression and should decrease the number of new terms which have no excuse for existence except their authors' ignorance of terms already existing. It is to be hoped that the book may be widely used by experimental zoologists in this country as well as in Germany.

C. M. C.

Handbook of Nature Study. By ANNA BOTSFORD COMSTOCK. Comstock Publishing Co., Ithaca, N. Y. 1912. Pp. xvii + 938, many illustrations, mostly from photographs.

Wherever else the nature-study enthusiasm may have subsided, it has not at Cornell nor in New York. The principal reason for this steadfastness is the presence and work at Cornell of Mrs. Comstock. She has had loyal support from Professor Bailey, and effective helpers in a half-dozen assistants and associates, but she it is who has been, and is, the burning center of the Cornell nature-study illumination.

To make the rays reach farther Mrs. Comstock has for twenty years issued the well-known informing leaflets of the Home Nature-Study Course, which have gone to thousands of teachers and homes in New York. To make

the Cornell light shine farther still Mrs. Comstock now issues this monumental handbook, which is so full of meat for nature-study teachers that it almost requires both hands to lift it. A thousand clay-coated pages are too many and too heavy for one volume. The book is already being brought out in two-volume form, animal study filling one volume, and plant and earth and sky study making up the second.

There is an amazing amount of information, very well digested and arranged, about animal and plant life and earth and sky, in the book. It is an encyclopedia for the nature-study teacher, and it is at the same time a manual of nature-study practise. It contains the facts and, also, precise directions for using them in the most approved way; most approved, that is, by the actual experience, during the last fifteen years, of Mrs. Comstock, her associates, and the many teachers who have been under her eyes in New York.

The book is prepared, confessedly, to meet the general condition of untrainedness in nature study on the part of school teachers. This lack of training includes a lack of knowledge of nature, and hence a lack of knowing what there is to see. Mrs. Comstock's book has for each of its subjects, a "teacher's story" which tells facts, and then a "lesson," based on these facts, for the teacher to use with the children. The lesson includes a "leading thought" which determines the special observations called for, a note on the special "methods" to use for the particular lesson, and then a set of "observations" put in question form. In each lesson, too, there are book references for the teacher to make use of, if desired, and usually a bit of quoted verse or prose from some writer who has, of his own initiative had a lesson in seeing, enjoying and loving nature, from the special subject in hand. There are, too, hosts of pictures, most of them very attractive ones made from photographs of live plants and animals, and there is a detailed table of contents, extensive list of books for reference, and a full index. The book is altogether practically made.

Where nature study has weakened Mrs. Comstock's "Handbook" should help it; where it has not yet taken root at all, the "Handbook" should go far toward giving it a beginning. For teachers and parents it should be *the* book of American nature study.

V. L. K.

STANFORD UNIVERSITY

JONGMAN'S PALAEOBOTANISCH LITERATUR[1]

THE third volume of Jongman's paleobotanical year-book has just been received in this country. It covers the years 1910 and 1911 and includes such titles as were omitted in the enumeration for 1908 and 1909. The arrangement is the same as in the two previous volumes, that is to say, the book is divided into two parts. The first part is a bibliography arranged chronologically by authors, each author's contributions being numbered, starting with number one for the first contribution in 1908 or subsequently. The second part, comprising pages 41 to 569, consists of a complete analysis of the literature listed in Part 1, and like it arranged alphabetically.

The real usefulness of a work of this kind depends entirely upon the skill and thoroughness with which the literature is digested, and in this respect Jongman's work seems to the writer to be of a much higher grade than that of comparable bibliographic undertakings. All old as well as new species discussed during the year are included, as well as all geological horizons, anatomical, morphological and phylogenetic contributions; all living species with which fossil species are compared, as well as purely botanical studies of such living forms as promise to shed light on fossil forms.

The work in short is exceedingly useful and botanists and paleobotanists are under a heavy debt of gratitude for the manner in which Dr. Jongman carries through this exceedingly laborious task. It is to be hoped that it will furnish the inspiration to some one to undertake a similar work for paleozoology.

[1] "Die Palaeobotanisch Literatur," Dritter Band, Die Erscheinungen der Jahre 1910 und 1911 und Nachträge für 1909, Fischer, Jena, 1913, 570 pages.

It is proposed to issue this paleobotanical volume each year. This laudable intention in a measure depends upon the acquisition of a regular subscription list and it is to be hoped that individual botanists and geologists as well as institutions will make the absurdly small expenditure that will insure the permanence and prompt appearance of this work.

EDWARD W. BERRY

JOHNS HOPKINS UNIVERSITY

The Aborigines of Minnesota. A Report based on the Collection of JACOB V. BROWER and on the Field Surveys and Notes of ALFRED J. HILL and THEODORE H. LEWIS. Collated, augmented and described by N. H. WINCHELL. Published by the Minnesota Historical Society. Illustrated by 36 half-tone page plates, 26 folded inserts and 642 figures inserted in the text. St. Paul, Minn., The Pioneer Company. 1911. Pp. xiv + 761.

This profusely illustrated monograph contains a mass of useful archeological and ethnological information, much of which is a monument to the scientific activities of the late Jacob V. Brower. Pages 1–579 treat of the Dakota, with some notes on the related Winnebago, etc.; pages 580–731 of the Ojibwa; while in appendices (pp. 732–743) are given Brebeuf's account of the solemn feast of the dead, from the *Jesuit Relations*, an account of the battle of Pokegama, from SCIENCE of 1886, a part of the *Walum Olum*, a tradition of the Delaware Indians, etc. A good index adds to the value of the book. Besides historical and geographical information, data as to treaties, and a detailed record and description (occupying pages 77–379) of earthworks in Minnesota, there are sections on the habitations, implements and instruments, manufactured articles, ornaments, food, pipes and smoking—also matter relating to death and burial, dances and "medicine," traditions, myths, etc., pictographs. A good deal of bibliographical material is included—on pages 25–62 is an annotated list of old maps of the Minnesota country, on pages 575–579 a partial bibliography of the Dakota, and on pages 707–731 (two columns to the page) a valuable list of Ojibwa personal names.

In connection with the discussion of the "pre-Indian inhabitants of Minnesota" (pp. 1–23) one should read the recent studies of the antiquity of man in North and South America by Dr. A. Hrdlička, and remember also that no convincing evidence of the existence of "*pre-Indian* inhabitants" of the new world has as yet been produced, either for Minnesota or for any other region of this continent. Nor can one rightfully speak of "the Eskimo quartz-workers of Minnesota" (p. 18). That the Algonkian stock preceded the Siouan in the occupation of Minnesota (p. 76) is an opinion here associated with the belief that "the Algonquian area in Colorado, shown on Powell's map of linguistic stocks, is perhaps a very ancient home of that stock," but this view is hardly to be approved. The Catawban area on the Atlantic (Carolinian) seaboard is taken as the "post-Glacial starting-point of the Siouan stock."

The recognition of "pre-Dakotan" mound-builders in Minnesota must be considered doubtful, but it is quite right to state (p. 408) that "there has been found in Minnesota nothing that would warrant the assignment of the mounds and effigies to any people enjoying superior culture or higher intellectual rank than the Indians who inhabited the state at the coming of the whites." Moreover, "in Minnesota there has not yet been discovered any evidence that the earthworks were designed for sacrificial purposes, nor for any religious ceremonies, nor primarily for points of observation," and, with the exception of the effigies, "there is nothing symbolic in their shapes or in their distribution."

Among the pictographs figured are a number from sandstone caves in Houston and Winona counties. The pictographs, attributable to the Dakota rather than to other Indian peoples, "belong in one grand category" and exhibit "a uniformity of style which points to but one people." The chief Algonkian inhabitants of Minnesota were the Ojibwa, but, according to the authors (p. 581),

there were pre-Ojibwa Algonkians in this region—probably the Cheyenne. Altogether, there is much good information and not a little speculation of a somewhat doubtful character in this volume. Some of the material deserves to be gone over again and made more of.

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SPECIAL ARTICLES

THE NATURE OF THE SUBSTANCES WHICH CAUSE THE BIOELECTRICAL POTENTIAL DIFFERENCES

IN previous papers[1] we have shown that the potential differences at the junction of the *intact* surfaces of plants and aqueous salt solutions exhibit sharply defined and reversible changes with the change in the concentration of the salt solution. The sense of these changes is such that we can speak of a reversibility for kations and the order of magnitude corresponds nearly with that calculated by Nernst's formula. A similar change was observed on the *injured* surface of certain plants and on animal organs.

We found, moreover, that the potential difference becomes smaller if we substitute an equimolecular acid solution for the salt solution, and we pointed out that this difference is of the order of magnitude of the so-called current of injury found in living organs. Finally we observed that the bioelectrical potential difference approaches a limit for increasing concentrations of the salt solution.

These characteristics are so definite that we undertook an investigation of the nature of the substances which are responsible for the potential differences at the junction of living organs and aqueous solutions. It was first ascertained that solid proteins, like gelatine or coagulated white of egg, show none of the potential differences characteristic for living organs. These characteristics were shown, however, by certain fatty compounds, like phosphatides (lecithin and kephalin), oleic, stearic and palmitic acids, and to a lesser degree by triolein. For technical reasons it was necessary to dissolve these substances in guaiacol or kresol.[2]

At the junction of a soluble lecithin solution and aqueous solutions were found the same changes in E.M.F. with the change in the concentration of the salt solution as we had previously found at the junction of a living organ (*e. g.*, the leaf of *Ficus elasticus*) and the aqueous solution, and moreover we noticed also the characteristic acid effect. In order to show to what extent the electromotive behavior of a lecithin solution resembles that of

Salt Solution	10 Per Cent. Lecithin in m-kresol E.M.F.	Difference.	Leaf of *Ficus elasticus* E.M.F.	Difference
m/10 KCl	+ .050 volt			
m/1250 KCl	.141 volt	.023 volt	.099 volt	.031 volt
m/250 KCl	.118 volt	.034 volt	.068 volt	.002 volt
m/50 KCl	.084 volt	.035 volt	.036 volt	.024 volt
m/10 KCl	.049 volt	.031 volt	.012 volt	
m KCl	.018 volt			
m/10 NaCl	.064 volt			
m/1250 NaCl	.150 volt	.022 volt	.141 volt	.038 volt
m/250 NaCl	.128 volt	.030 volt	.103 volt	.036 volt
m/50 NaCl	.098 volt	.037 volt	.067 volt	.034 volt
m/10 NaCl	.061 volt	.031 volt	.043 volt	
m/2 NaCl	.030 volt			
	10 per cent. lecithin in guaiacol.			
m/10 KCl	+ .042 volt	.042 volt		
m/10 HCl	± .000 volt			

[1] SCIENCE, XXXIV., 884, 1911; XXXV., 970, 1912. *Biochem. Ztschr.*, 41: 1, 1912; 44: 303, 1912.

[2] Beutner, *Jour. Amer. Chemical Society*, 35: 344, 1913.

certain living plant organs, we will publish the results of two series of experiments, one on a 10 per cent. solution of lecithin in m-kresol and the other on the leaf of *Ficus elasticus*. In both experiments the E.M.F. at the junction of these bodies and aqueous solutions of various concentrations was measured.

The differences observed for the same degree of dilution are almost identical in both cases and the drop in potential, if we substitute $m/10$ HCl for $m/10$ KCl, corresponds for a 10 per cent. lecithin solution to the change observed in the case of the intact apple or leaf of *Ficus elasticus* under the same condition.

We obtained similar effects with chemically pure kephalin which Dr. Levene was kind enough to give us, and with triolein, oleic, stearic and palmitic acids dissolved in guaiacol or kresol. The kresol and the guaicol without these lipoids gave concentration effects of a much smaller order of magnitude. Cholesterin gave no concentration effects.

We then made experiments with extracts of the apple in guaiacol and this extract gave the same results as the apple itself.

We may therefore conclude that the concentration effects on the E.M.F. observed in certain plant organs are due to the fact that these organs possess a surface consisting of a phosphatide or some fatty substance. It would be wrong to conclude that the same is true for the surfaces of all cells or organs. In a number of organs, *e. g.*, the striped muscle, the concentration effects are extremly small and it requires further experiments to explain their electromotive behavior.

JACQUES LOEB
R. BEUTNER

THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH,
April 15, 1918

METEOR DUST AS A MEASURE OF GEOLOGIC TIME

SOME years ago[1] I suggested a possible method of measuring the rate of formation of strata, and so of geologic time, by the proportion of meteor dust contained in the strata, which method seems, now, to be really practical. Meteorites are continually striking the earth. According to the Britannica, 20,000,000 visible meteorites strike the earth each day and the telescope might reveal twenty times as many. I then assumed that they weighed a gram and were 10 per cent. nickel. This would mean 28.6 grams of nickel per square kilometer, per year. Professor W. H. Pickering has shown reason to believe that the visible meteorites are 15 to 18 cm., or, at any rate, 5 to 7 cm. in diameter,[2] and Farrington[3] finds for the average specific weight 7.8 and for the average per cent. of iron and nickel, in a large number of meteorites, 72.06 and 6.5, respectively. Assume that the invisible meteorites make up for any exaggeration in Pickering's largest figure and that we have 7,300,000,000 meteors, weighing 23,700 grams each, striking the earth in a year, and we would have 340,000 grams per square kilometer of cosmic material per annum, of which 20,000 grams are nickel.

The .001 to .0001 grams per square meter of partly cosmic dust found on a 30-millimeter layer of granular snow by A. E. Nordenskjold,[4] Lat. 80° N., Long. 15° E., might be a small part of the year's accumulation.

The redness of the residual red clay may be due to the cosmic dust slowly added in this slow process. This should also be a large part of the abysmal red clay of the great depths of the ocean. Of this red clay one square kilometer, one meter thick, would make 2,500,000 tons, if the specific gravity is 2.5. It contains, according to Clarke,[5] 0.0077 per cent. more of nickel than the average igneous rock. Assuming the nickel of the

[1] Annual report Michigan Geological Survey, 1901, p. 243.

[2] *Astrophysical Journal*, 1909, p. 378; 1910, p. 89.

[3] Field Museum of Nat. Hist., Pub. 151, pp. 213–14.

[4] *Poggendorff's Annalen*, Bd. 151 (1874), p. 158. See also "Studien und Forschungen veranlasst . . . Norden," von A. E. Nordenskjold, Leipzig, 1885. *Journal f. prakt. Chemie*, N. F., Bd. 9 (1874), pp. 356–67.

[5] Data of Geochemistry, U. S. G. S. Bulletin 330, pp. 490 and 27 (.0307 and .023).

igneous rock to fairly represent the volcanic ash, which is another large part of the abysmal clay, a meter thick would contain 192.5 tons of nickel extra per square kilometer. It would take 8,700 years to accumulate this extra 192.5 tons of nickel in a meter at the rate of 20,000 grams per year. Now the red clay has, certainly, formed very slowly, as shown by the abundance of sharks' teeth and whales' ear bones, as well as the manganese and meteor dust.[8] The man in the world best qualified to guess in an after-dinner conversation expressed to me his guess that 500 feet of the red clay would represent all geologic time. At the above rate, 500 feet, *i. e.*, 152.5 meters, would equal 13,000,000 years. Now this is of the order of the figures of other estimates of the earth's age, suggestively near to other short estimates, when we see that we have taken Pickering's maximum estimate of the size of meteors. If we took Pickering's smaller figures for the size of the meteorites, we could get estimates of age as great as the larger estimates of the age of the earth.

My object, at this time, is to urge the members of the talked-of Arctic and Antarctic expeditions, or, in fact, any one in snowy climates, to complete Nordenskjold's observations by finding the amount of cosmic dust in a large amount of snow, accumulated in a known time, determined by annual rings or otherwise. It may, also, be well to test especially for the amount of nickel in strata which are thought to have formed very slowly.

I have no doubt, also, that within this century, there will be drilled a hole in the bottom of the sea which will give us the other datum to be determined.

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[8] *Bull. Mus. Royal*, 1884, p. 85. "Sediment de Mer Profounde."

THE MILWAUKEE MEETING OF THE AMERICAN CHEMICAL SOCIETY

ALTHOUGH the American Chemical Society changed its time of meeting from winter to spring there was no falling off in the attendance at the Milwaukee meeting, for in spite of the distance from many of the local sections some four hundred members gathered for the meeting, as well as thirty guests.

The council meeting was held on Monday evening, March 24, and it was voted that the next meeting should be held in Rochester, New York, early in September. Other business of a general character was considered and the reports of all committees received.

On Tuesday morning the following four papers were given in general session, and with the exception of the last were fully illustrated:

Joel H. Hildebrand: "Some Applications of the Hydrogen Electrode in Instruction, Analysis and Research."

D. M. Buck: "Copper in Steel. The Influence on Corrosion."

H. E. Howe: "Some Projection Experiments with Spectra."

Wilder D. Bancroft: "The Theory of Emulsions."

On Tuesday afternoon excursions were held to the plant of the Jos. Schlitz Brewing Company, to the gas and coke plant; and the works of the Pfister & Vogel Leather Company and the Vilter Manufacturing Company were also open to the members.

In the evening a complimentary smoker was held in the Fern Room of the Hotel Pfister, at which Mayor Bading of Milwaukee was present.

On Wednesday there were meetings at Marquette University of the Agricultural and Food Division, the Biological Chemistry Division, Industrial Chemists and Chemical Engineers, the Pharmaceutical Chemistry Division, the Physical and Inorganic Chemistry Division and the Rubber Section.

On Wednesday evening Professor Julius Stieglitz, of Chicago, gave a public lecture on "Combustion," which was largely attended by the members as well as by the citizens of Milwaukee, probably eight hundred people being present.

On Thursday the meetings of the Divisions continued and the Organic Chemistry and Fertilizer Divisions also met.

In the afternoon excursions were taken to Pabst Brewing Company and the Pfister & Vogel Leather Company and in the evening a subscription dinner was held at the Hotel Pfister.

On Friday seventy-five of the members went by special train to Madison, Wisconsin, where they were received by committees of the Wisconsin Section of the American Chemical Society and con-

ducted to the various places of interest in Madison. The chemical laboratories of the University of Wisconsin, the capitol and the forest products laboratory were visited. A luncheon was served to the visitors, at which President Van Hise presided.

All members of the society who went to the Milwaukee meeting were well repaid for the journey.

The following is a list of papers presented, with abstract where abstract was furnished:

GENERAL MEETING OF ALL DIVISIONS AND SECTIONS

JOEL H. HILDEBRAND: *Some Applications of the Hydrogen Electrode in Instruction, Analysis and Research.* (Illustrated.)

The change of hydrogen or hydroxyl-ion concentration during the neutralization of acids and bases, the precipitation of hydroxides, etc., gives a very remarkable insight into the nature of the reaction. This change can be followed by means of the hydrogen electrode, of which a simple form was described, together with apparatus allowing its potential to be easily determined with a voltmeter. Curves were thrown on the screen showing the variation of potential, and consequently of hydrogen and hydroxyl-ion concentration, during the neutralization of various acids and bases. From these it was pointed out how such things could be easily determined as the proper indicator to use in a given titration, the degree of hydrolysis of salts, the dissociation of weak acids and bases, the way to prepare normal salts where hydrolysis takes place, the effect of structure on the strength of organic acids, etc. Curves representing the titration of salts such as borax and sodium carbonate were shown and conclusions drawn similar to those just mentioned. Others were shown representing the precipitation of various hydroxides, from which could be drawn conclusions regarding the behavior towards various reagents and the separation from each other. Owing to the difference in solubility of magnesium and calcium hydroxides, magnesium can be titrated in the presence of calcium, allowing its rapid determination in limestone, etc. The same method can be used with a platinum electrode to determine the oxidizing power of solutions, illustrated by the titration of iron with bichromate, avoiding the use of the external indicator.

D. M. BUCK: *Copper in Steel. The Influence on Corrosion.* (Illustrated.)

H. E. HOWE: *Some Projection Experiments with Spectra.* (Illustrated.)

WILDER D. BANCROFT: *The Theory of Emulsions.*

DIVISION OF AGRICULTURAL AND FOOD CHEMISTRY

H. E. Barnard, *chairman*

Glen F. Mason, *secretary*

H. E. BARNARD: *The Status of Food Legislation in the United States.*

A brief sketch of the history of food legislation in the United States followed by a discussion of the various types of laws, such as the Pure Food Law, Meat Inspection Law, Sanitary Food Law and Cold Storage Law, enacted for the improvement and control of the food industry. The special features of each law are described and the methods employed in their enforcement detailed.

CARL L. ALSBERG, F. RABAK, H. H. BUNZELL and O. F. BLACK: *Studies upon Maize.*

W. D. BIGELOW: *The Equilibrium between Sugars and Sulphur Dioxide in Dried Fruit.*

The time required for sulphur dioxide and aldehydes to unite prevents the formation of this compound in fruit that is dried quickly by artificial heat, but permits its formation in fruits that require a number of days for drying. Thus evaporated apples are nearly free from sulphur dioxide, while sun-dried peaches and apricots contain considerable amounts. The content of the latter is much greater because of the practise in the packing-house of dipping the dried fruit in water and again sulphuring and packing in boxes without subsequent drying.

The gradual disappearance of sulphur dioxide in dried fruit depends on temperature and humidity. The dextrose sulphurous acid compound is quite stable but is broken up by water to a sufficient extent to form an equilibrium between this compound and the free sulphurous acid. The free acid is subject to evaporation and oxidation and the equilibrium is, of course, maintained by the hydrolization of an additional amount of the compound.

W. D. BIGELOW: *The Influence of Cooking on the Sulphurous Acid Content of Dried Fruit.*

The methods usually employed in cooking fruit were ascertained by 525 letters of inquiry sent to residents of 21 states. The usual method appears to be to soak a number of hours without previous washing and cook for one or two hours in the water in which it is soaked. During the cooking about 10 per cent. of the sulphur dioxide present is oxidized to sulphate and 25 to 35 per cent. of it is volatilized. Preliminary washing removes 2–3 per cent. of the sulphur dioxide, and 35–50 per cent. more is removed when the fruit is soaked overnight in two or three times its weight of water and the latter is poured off and

discarded. By the latter practise there is also lost from a quarter to a third of the soluble solids of the fruit.

EDWARD BARTOW: *The Effect of Chicago's Sewage on the Illinois River.*

Tests made during a dry season in July show a very low content of dissolved oxygen in the river as far down as the Marseilles dam. Below the dam there is a gradual rise as far as Peoria, below which there is a slight drop, followed by a rise and higher values throughout the remainder of the river. During high water and in colder weather more oxygen is present in the upper part of the river, but there is evidence that the sewage is carried farther down the stream. A study of the fish life of the river by Professor S. A. Forbes shows no fish present in the river above the Marseilles dam. There is an increase in the number of fish found in the lower part of the river and the amount of plankton is very much greater than before the opening of the drainage canal.

A. HUGH BRYAN: *The Polarization of Light-colored Sugar Solutions.*

In polarizing light-colored sugar solutions, such as syrups, honeys, extracts, etc., with saccharimeters, using white light, it is often hard to neutralize the field, one side possessing a bluish or greenish tinge and the other a white or reddish one. This results from differences in rotation dispersion of the sugar solution and quartz wedges. In order to reduce this to a minimum, the white light used as a source of supply for the polariscope should be filtered through a neutral solution of bichromate of potash. This removes the blue and violet rays which are the main disturbing ones. For solutions of sucrose, a layer 1½ cm. thick of a 6 per cent. solution or 3 cm. layer of a 3 per cent. solution has been found sufficient, while for commercial glucose the percentage composition should be double for the same layer of solution, that is, 12 per cent. for a 1½ cm. cell or 6 per cent. in a 3 cm. cell. Dark-colored sugar solutions naturally tend to filter the light. Hence, there is little trouble experienced when polarizing them without the light filter cell, but many sugar chemists use the cell in case of all polarizations.

SLEETER BULL and A. D. EMMETT: *The Protein and Energy Requirements of Fattening Lambs as Determined by a Study of American Feeding Experiments.*

In this compilation of the American literature upon the protein and energy requirements for fattening lambs, 49 experiments from 16 different agricultural experiment stations were reviewed. The experiments embraced 259 lots of 5,005 lambs. The data were classified into four groups, lambs weighing 50–70 pounds, 70–90 pounds, 90–110 pounds and 110–150 pounds. The average daily consumption of digestible protein in pounds, the average net energy in therms, and the average daily gains were reported and summarized for each group.

JOHN G. DIGGS: *Analyses showing the Composition of the Different Grades of Commercial Pack Peas.*

This paper gives a complete analysis of the various grades of canned peas put out by a single packing concern. It was thought that in one plant where uniform methods were used in grading, sizing and packing a closer distinction might exist between the composition of the different brands or grades. The basis for determining the three brands was the gravity of the first pea. The average of analyses of grades of each brand show: the younger immature peas contain eighteen per cent. more water than the oldest ones, the crude fiber decreases from 10.25 per cent. to 7.15 per cent. (water-free basis) as the pea matures, starch increases from 41 per cent. to 53 per cent. with maturity, sugar decreases as the pea grows older.

JOHN G. DIGGS: *Some Abnormal Factors of So-called Farmers' Cider Vinegar.*

This paper gives the analysis of eighteen samples of supposed cider vinegar produced by cask fermentation. In many of the samples fermentation was found to have been arrested before completion, these samples containing high percentages of sugar. The maximum factors in grams per 100 c.c. were: acid, 10.25; total solids, 9.64; sugar, 5.97; non sugars, 5.06; and glycerine, .51. Some of the samples were watered and to some sugar and acetic acid had been added. The difficulty of manufacture of vinegar by this process without at least some training is shown.

J. T. DONALD: *Methods for the Accurate Determination of Saltpeter.*

J. O. HALVERSON: *The Modified Babcock Method for Fat in Sweetened Dairy Products—Ice Cream.*

The need of a rapid volumetric method for ice cream is shown. The Babcock test is not applicable to sweetened dairy products on account of the well-known charring action of the acid on the sugar. If the sugar solution could be readily drained off, the ordinary Babcock method could then be used. This is accomplished by centri-

fuging the fat to the top as in the Babcock test, then drawing off the acid-sugar solution through a small glass stopcock fused on near the bottom of the test-bottle. This is the essential modification in this method.

A new ice-cream modified test-bottle, graduated to 25 per cent. for an 18-gram charge, is shown.

Results of 350 determinations on different ice-creams show that results consistent with the Roese-Gottlieb ether extraction method are obtained, though running 0.6 per cent. low. The residual fat lost in the drained-off acid-sugar portion is shown to average the same as that lost in the Babcock test of cream.

The maximum variation of the individual readings compare favorably with those of the Roese-Gottlieb method.

The modified method in detail with numerous tables of data are given, also two figures of the modified Babcock test and of the modified test bottle.

P. W. HOLTZENDORFF: *The Separation and Identification of the Permitted Coal-tar Colors in Foods.*

The method is confined to the permitted colors. Advantage is taken of difference in chemical composition and extraction by immiscible solvents to effect separation. Identification tests are made on the dry color and in aqueous solution, after well-known methods, particularly the reactions obtained with concentrated H_2SO_4.

ARDEN R. JOHNSON and B. W. HAMMAR: *Specific Heat Observations on Milk and Cream.*

ARDEN R. JOHNSON and ROY E. SMITH: *A Thermal Method for the Determination of Ratio of Congealed to Uncongealed Moisture in Frozen Soils.*

A. MCGILL: *Some Phases of National Food Control.*

A. E. PERKINS: *A Simple and Convenient Method for Determining the Salt Content of Butter.*

This paper describes a method for the determination of salt by titrating a solution of 5 or 10 grams of butter in 20 or 30 c.c. of commercial acetone with silver nitrate, using potassium chromate as an indicator. The author states that the method yields results entirely comparable with the longer volumetric or gravimetric methods formerly used.

Equal parts of commercial alcohol and ether may be substituted for the acetone with equally good results.

A. E. PERKINS: *A Note Regarding an Absorption Tube and Receiver used in the Kjeldahl Nitrogen Determination.*

The author states that successful use has been made of a 2-inch glass funnel and glass jar with straight sides used as the absorption tube and the receiver, respectively.

He states that the advantage is the large surface of acid that is present for the absorption of ammonia vapors, and very little bubbling occurs. No trouble has been experienced with the acid striking back towards the distilling flask.

C. S. ROBINSON and O. B. WINTER: *The Nature of Nitrogenous Compounds in Peat Soils.*

This paper takes up the study of the protein content of peat soils. Van Slyke's method for the determination of amino nitrogen is used to study the amount of nitrogen converted into the amino form under various conditions of acid and alkaline digestion. About 27 per cent. of the total nitrogen was converted into the amino form on heating with 25 per cent. sulphuric acid 96 hours and about 50 per cent. by heating with 5 per cent. NaOH for 150 hours.

R. H. ROBINSON: *Some Chemical Changes taking Place during the Embryonic Development of the Chick.*

S. H. ROSS and N. HENDRICKSON: *A Simple and Efficient 20° C. Bacteriological Incubator.*

A very satisfactory 20° incubator was made from an ordinary refrigerator, size 20 in. × 29 in. × 46 in., by installing two heating coils, 0.2 ampere, and a disc type thermoregulator in the refrigerating compartment. The thermoregulator actuated a circuit breaker and connection was made to a lighting circuit. With care in regulating the amount of ice the temperature was easily maintained between 19.5° and 20.5° C.

J. F. SNELL: *The Detection of Adulteration in Maple Syrup and Sugar.*

H. V. TARTAR and B. PILKINGTON: *A Comparative Study of the Composition of Hops Grown in Different Parts of the World.*

H. V. TARTAR and L. A. BUNDY: *A Note on the Soluble Arsenic in Mixtures of Lead Arsenate and Soap.*

J. BOSLEY THOMAS and EDGAR A. SANDMAN: *Some Results of the Hypochlorite Disinfection of the Baltimore City Water Supply.*

The period covered by this report extends from January 1 to December 31, 1912. Calcium hypochlorite was applied at the effluent of the im-

pounding reservoir just before the water entered a seven-mile conduit, in amounts of 1.0 part per million available chlorin from January 1 to July 15, and 1.5 p.p.m. from January 15 to the end of the year.

Samples were taken daily from the untreated water and from the treated water at the end of the tunnel as well as from the effluents of several storage reservoirs. These samples were examined for the bacterial count and members of the *B. coli* group, and averaged by months, the *B. coli* organisms being calculated to numbers per cubic centimeter by the use of portions of the samples varying by a multiple of ten from .01 to 100 c.c.

The results of the treatment of this water supply have been reductions varying between 92 and 99 per cent. in the bacterial count and almost entire elimination of members of the *B. coli* group, the reductions in these organisms being between 92 and 100 per cent., with 99.99 per cent. reductions during five months and 100 per cent. during two months of the year.

The reduction in the number of cases of typhoid fever occurring in Baltimore during 1912 is 31 per cent., compared with an average of the number of cases occurring during the years from 1906 to 1910, and 24 per cent., compared with the cases occurring during 1911, in the last six months of which the water supply was treated.

J. E. HARRIS: *Soil Acidity.*

EDWARD GUDEMAN: *Glucose Analyses.*

Determinations of the mineral constituents of confectioner's glucose, representing over 1,000 samples examined during the years 1902 to 1913, were submitted in chart form, the curves showing the maxima, minima and averages of the total ash, chlorides and sulphurous oxide.

The results show that no fixed ratio exists between these ingredients. The chlorides approximate two thirds of the total ash, figured as sodium chloride. The sulphurous oxide (SO_2) seems to vary inversely to the other ingredients. The fluctuations in these ingredients are so great that determinations of mineral matter in glucose give no bases for judging the quality of the product.

The table following shows the great variation in the maxima, minima and averages for the years 1902 to 1913:

Total Ash:

	Parts Glucose (D.S.)
Maxima	84–158 parts to 10,000
Minima	30– 50 parts to 10,000
Averages	52– 82 parts to 10,000

Chlorides:

(NaCl)	Maxima	68–92 parts to 10,000
	Minima	18–38 parts to 10,000
	Averages	36–82 parts to 10,000

Sulphurous Acid:

(SO_2)	Maxima	160–350 parts to 1,000,000
	Minima	10–165 parts to 1,000,000
	Averages	60–240 parts to 1,000,000

DIVISION OF ORGANIC CHEMISTRY

Treat B. Johnson, *chairman*

William J. Hale, *vice-chairman and secretary*

LLOYD M. BURGHART and RALPH H. MCKEE: *The Action of Cyanimido Ether on Esters of Amido Acids.*

It has previously been shown that cyanimido ethyl ether gives with esters of anthranilic acid the oxygen ethers of benzoylen urea. The study of the reaction has been continued, particularly as to the character of the intermediate steps in the reaction and also as to the possibility of forming seven and eight atom rings containing either the group —CO—NH—CO—NH— or the group —CO—N=OC_2H_5—NH—.

The evidence obtained indicates that there is first formed an open chain compound by the elimination of prussic acid and that this is followed by the elimination of alcohol with the consequent formation of a ring of four carbon and two nitrogen atoms.

The authors were unable in any case to bring about the formation of a similar eight-atom ring, though many trials were made using para amino-benzoic ethyl ester as a starting material.

F. W. HEYL, F. E. HEPNER, S. K. LOY: *Zygadenine. The Crystalline Alkaloid of Zygadenus intermedius.*

Among the poisonous plants of the range death camas is most abundant and is the cause of most cattle poisoning in Wyoming. In the work which has been taken up at the Wyoming Experiment Station, upon the problem of poisonous plants, this one has been examined first.

A crystalline alkaloid melting at 200°–201° and having the formula C_{39} H_{63} NO_{10} has been isolated and its toxic effects studied. It was found to be similar to veratrine.

F. W. HEYL and F. E. HEPNER: *Some Constituents of the Leaves of Zygadenus intermedius.*

The study of this plant was continued and the resin examined, as statements occur in the literature ascribing poisonous properties to this part of the plant.

The chemical and physiological study demon-

strated the inert nature of the resin and proved that the poisonous properties reside in the alkaloidal fraction entirely.

The substances isolated from the plant include quercitin, dextrose, a phytosterol, a hydrocarbon hentriacontane, oleic acid, linoleic acid, iso linoleic acid. The solid fatty acids present were stearic, palmitic and cerotic. A neutral substance to which no formula has been assigned was found in the ether extract of the resin, and this fraction also contained a polyhydric alcohol similar to ipuranol.

C. G. Derick and J. H. Bornmann: *Rearrangements of N-Acyl Aromatic Amines.*

The fact that intramolecular rearrangements of the *N*-acyl aromatic amines proceed in the direction to decrease their ionization is tested out for *N*-diacetyl, *N*-dipropionyl, *N*-acetyl anilines and their corresponding aminoketones. It is found to hold and is a very satisfactory criterion for the possibility of rearrangements of this type. The criterion is found to hold for the rearrangement of acetophenone oxime into acetanilide. By combining the senior author's measure of negativity with the above work, it is possible to state a limit beyond which two acyl-radicals must be substituted for the aminic hydrogen before rearrangement will be possible.

P. N. Evans and Lena M. Sutton: *The Efficiency of the Preparation of Ether from Alcohol and Sulphuric Acid.*

The completeness of the reaction was determined by comparing the fractionation results of the successive distillates with those of artificial mixtures corresponding to the theoretical products at various degrees of completeness; the efficiency proved to be about 40 per cent., and this was maintained until there remained in the generating flask a charred and semi-solid residue amounting to only about one twentieth of the original acid in weight.

The yield of distillate was in some experiments as high as 176 times the volume of the original acid, containing ether amounting to 40 times the volume or 16 times the weight of the acid used.

The final fall in efficiency was due, therefore, to the loss of sulphuric acid and not to the accumulation of water formed in the reaction. That the accumulation of water is not the interfering factor was further shown by the normal course of the reaction when dilute sulphuric acid was employed.

From 15 to 20 per cent. of the sulphuric acid used was accounted for as sulphur dioxide. Other by-products are being further investigated.

Ben H. Nicolet and Treat B. Johnson: *The Constitution of Surinamine.*

Surinamine, which was isolated by Giutyl in 1868 from a species of leguminous trees from Brazil (*Ferreira spectabilis*) is a methyl derivative of tyrosine,

$$HO \cdot C_6H_4 \cdot CH_2 \cdot CH \cdot (NHCH_3)COOH,$$

and not a higher homologue,

$$HO \cdot C_6H_4 \cdot CH_2CH_2CH(NH_2)COOH.$$

This methyl derivative of tyrosine has been synthesized in this laboratory and found to be identical with the natural base, which was isolated by Giutyl. This conclusion has been confirmed by Professor Dr. Guido Goldschmiedt, to whom we are indebted for a sample of Giutyl's original base.

Treat B. Johnson: *A New Method of Synthesizing β-Ketone Esters.*

A new method of synthesizing certain types of β-ketone esters has been developed by the application of Refounatsky's reaction. Our synthesis represents the first phase of Refounatsky's reaction. Substituted ketone esters of the general formula $C_2H_5OCH_2COCH(R)COOC_2H_5$ can easily be obtained by the action of esters of α-halogenated acids on esters of hydroxy acids in the presence of amalgamated zinc. The method has been applied successfully in several cases.

Lewis H. Chernoff and Treat B. Johnson: *Pyrimidine Nucleosides.*

Robert Bengis and Treat B. Johnson: *New Thiohydantoin Condensation Products.*

A continuation of the hydantoin researches from the Sheffield Laboratory. This investigation deals with the possible precursors of the naturally occurring base adrenaline. By application of our own methods of synthesizing α-amino acids from thiohydantoins, several new amino acids of biochemical interest have been prepared.

William J. Hale: *The Constitution of "Acetylacetone-Urea."*

This compound is to be considered as a dimethyl-oxypyrimidine or dimethyl-pyrimidone. The presence of an hydrogen atom attached to one of the nitrogen atoms of the pyrimidine nucleus was proved by methylation with diazomethane.

W. A. Noyes and L. F. Nickell: *Decomposition of Isodihydroaminocampholytic Acid with Nitrous Acid.*

Isodihydroaminocampholytic acid was prepared by the method of Noyes and Knight (*Jour. Am. Chem. Soc.*, 32: 1669). In the saponification of β-amidoisocamphoric ester some d-camphoric imide was formed. Isodihydroaminocampholytic acid forms the same anhydride as dihydroaminocampholytic acid; the free acid does not form an inner salt in solution. By decomposing this acid with nitrous acid, a hydrocarbon, d-campholytic acid, l-trans-dihydrohydroxycampholytic acid and l-campholytolactone are formed. l-campholytolactone on hydrolysis gives l-cisdihydrohydroxycampholytic acid. The Walden inversion occurs only in the formation of l-campholytolactone, which is 1.8 per cent. of the acid decomposed.

R. S. Potter and W. A. Noyes: *Are Ammonium Compounds Atomic or Molecular?*

The authors have shown that in amino camphonanic acid the amino and carboxyl groups combine to form an inner salt. Similar acids, amino dihydrocampholytic, amino homo camphonanic and amino homo dihydrocampholytic, probably do not form this inner salt. The above conclusions were arrived at through a consideration of the rotations of the acids mentioned, their hydrochlorides, sodium salts. The anhydrides and nitroso derivatives of the acids were also prepared. The conclusion as to the structure of the ammonium inner salt is taken as a refutation of Werner's theory of the structure of ammonium compounds.

O. A. Beath and Edward Kremers: *A Crystalline Resin Acid from the Digger's Pine.*

The oleoresin of *Pinus sabiniana* is of special interest not only because it contains heptane in place of pinene of the corresponding oleoresins of the genus *Pinus*, but also because its resin acid until recently defied all attempts at crystallization. A crystalline product has been obtained by two different methods.

C. D. Geidel and Edward Kremers: *The Oxidation of Indigo Blue by Phellandrene "Peroxide."*

A preliminary report on the relative capacity for oxygen conveyance of phellandrene as compared with pinene and limonene.

Edward Kremers: *Direct Halogen Substitution as a Laboratory Experiment in Organic Chemistry.*

Text-books have always emphasized the direct substitution of hydrogen of the methane series of hydrocarbons by halogen. Nevertheless, there possibly does not exist a laboratory manual to-day which provides an experiment illustrating this important reaction. This is due, no doubt, to the absence of suitable hydrocarbon material. Such a material, however, can now be provided, if wanted, in the form of normal heptane from either the Diggers pine or Jeffrey pine of California. The substitution experiment can be supplemented by a series of reactions illustrative of Schorlemmer's classical experiments on the constitution of the paraffin hydrocarbons.

Carl O. Johns and Emil J. Baumann: *Researches on Purines. 2-Methylmercapto-6, 8-dioxypurine and 2-Methylmercapto-6-oxy-8-aminopurine.*

2-Thio-4-amino-6-oxypyrimidine was alkylated in alkaline solution by means of dimethyl sulphate giving 2-methylmercapto-4-amino-6-oxypyrimidine. By means of nitrous acid this substance was converted to 2-methylmercapto-4-amino-5-nitroso-6-oxypyrimidine. This latter compound was reduced to 2-methylmercapto-4, 5-diamino-6-oxypyrimidine by means of ammonium sulphide. The diamino pyrimidine was heated with urea and gave 2-methylmercapto-6, 8-dioxypurine which on hydrolysis with hydrochloric acid gave uric acid. When the above-mentioned diaminopyrimidine was heated with guanidine thiocyanate it gave 2-methylmercapto-6-oxy-8-aminopurine, which could also be hydrolyzed to uric acid.

Carl O. Johns and Albert G. Hogon: *Researches on Purines. 2-Thio-6, 8-dioxypurine; 2, 8-dithio-6-oxypurine; a New Method of Preparing Xanthine and Uric Acid.*

When 2-thio-4-amino-6-oxypyrimidine was heated with urea it gave 2-thio-6, 8-dioxypurine. When the latter compound was boiled with chloracetic acid we obtained 6, 8-dioxypurine-2-thioglycollic acid, which on heating with hydrochloric acid gave uric acid. When 2-thio-6-oxypurine was heated with chloracetic acid we obtained 6-oxypurine-2-thioglycollic acid. On hydrolysis with hydrochloric acid this gave xanthine.

When 2-thio-4-amino-6-oxypyrimidine was heated with urea it gave 2, 8-diothio-6-oxypurine. With chloracetic acid this gave 6-oxypurine-2, 8-dithioglycollic acid.

BIOLOGICAL CHEMISTRY SECTION

Carl L. Alsberg, *chairman*

I. K. Phelps, *secretary*

J. H. Long: *Some Conditions Affecting the Stability and Activity of Certain Ferments.*

The action of certain body ferments on each other has been long discussed. As to the extent of this mutual action there is still much confusion, which is in a large measure due to a failure to give proper weight to the behavior of the medium in which the ferments act.

It is not possible to explain the action of pepsin on trypsin and amylopsin, for example, until the influence of the acidity, the alkalinity or the salt content of the medium is eliminated or fully defined. The paper deals with determinations in this direction, with special reference to the condition of amylopsin action. Glycerol extracts of the pancreas, as well as a number of commercial products were used in the investigations.

JACOB ROSENBLOOM: *The Cholesterol and Cholesterol-esters of the Blood in Xanthoma Tuberosa Multiplex.*

JACOB ROSENBLOOM: *A Chemical Examination of the Brain of a Syphilitic Fœtus.*

W. D. BANCROFT: *A Problem in Metabolism.*

F. M. MCCLENAHAN: *The Development of Fat in the Black Walnut (Juglans nigra).* II.

W. A. WITHERS and J. F. BREWSTER: *A Study of the Renal Output of Rabbits Dying from Cottonseed-meal Poisoning.*

R. A. GORTNER: *Studies on the Chemistry of Embryonic Growth. I. Certain Changes in the Nitrogen Ratios of Developing Trout Eggs.*

The distribution of certain fractions of the nitrogen was determined in trout eggs at various stages of embryonic development, beginning with eggs less than 24 hours old and ending with the young fish which were ready to take food.

It was found that no nitrogen left the egg before hatching, but that the monamino-acid nitrogen diminished and a gain of basic nitrogen took place. No considerable amount of urea or uric acid was formed.

After hatching the nitrogen is rapidly lost, until 21 days after hatching 21.96 per cent. of the total nitrogen has been eliminated. At this period the total weight (dry at 100°) has diminished 25.35 per cent.; 37.26 per cent. of this loss being due to non-nitrogenous compounds (fats, etc.) and 62.73 per cent. to proteins (N. × 6.25).

A study of the form of the nitrogen which is eliminated showed that nearly all of the basic nitrogen is retained in the new organism, nearly all of the nitrogen liberated being monamino-acid nitrogen.

The significance of these findings as regards our present knowledge of the chemistry of embryonic growth, is discussed.

The paper will be published in *The Journal of the American Chemical Society.*

PHILIP ADOLPH KOBER: *The Nephelometric Determination of Proteins. I. Casein and Globulin in Milk.*

Results in previous papers showed that proteins can be rapidly and accurately estimated with a nephelometer. After removing the fat from milk, casein and other proteins may be estimated directly in this way. While the official method takes two or more days to determine casein, globulin and albumin in milk, it can be done nephelometrically in less than 30 minutes. The nephelometer described in a previous paper is shown with several improvements.

G. O. HIGBY: *A Study of Well Water as a Cause of Typhoid Fever.*

This investigation was begun in August, 1910, at Delaware, Ohio, because of the prevalence of typhoid fever in the city, there being 26 cases on August 1 in a city of 10,000 inhabitants. The hydrant water having been proved safe, suspicion fell upon the well water, and samples from 65 wells were collected and examined chemically and for the presence of the colon bacillus between September 1, 1910, and June 1, 1912.

Serious local pollution of the wells was discovered and reported to the city health officer, resulting in the closing of some wells and the cleaning and abandoning of many cesspools. The number of typhoid cases in the city has been as follows: 1909, 18 cases; 1910, 34 cases; 1911, 7 cases; 1912, 10 cases (seven of these on the outskirts of the city, where the water pipes have not been laid); 1913, no cases up to March 22.

L. KNUDSON: *Influence of Cane Sugar on the Production of Tannase by Aspergillus Niger.*

M. X. SULLIVAN: *Molds as a Factor in the Formation of Certain Nitrogenous Organic Soil Constituents.*

Some thirty-five to forty different substances have been found in the organic matter of the soil. In some of the soils, mold growth was very evident. Molds were taken from soil and implanted on Raulin's solution. After several replantings 70 liters in bottles were inoculated with what has been identified as a variety of *Penicillium glaucum.* After a period varying from three to five weeks, the mold mycelium and the culture solution were examined for various organic constituents. On the air-dried molds have been found, a trace

of xanthine, much hypoxanthine, some guanine, adenine, histidine, arginine in very small quantity, probably lysine, thymine, choline, mannite, pentoses, cholesterol bodies and lipoids resembling cerebroside, a small amount of an unidentified hydroxy-fatty acid, and large amounts of oleic and palmitic acid and some stearic acid. In the culture solution was found fatty acids, guanine, adenine and hypoxanthine, a small amount of histidine, pentose sugar, unidentified aldehydes, mannite and probably thymine. The general conclusion is drawn that molds, and other microorganisms play a considerable rôle in the formation of organic soil constituents.

J. J. Skinner: *Effect of Salicylic Aldehyde as a Soil Constituent.*

The isolation and identification of salicylic aldehyde in soils is pointed out.

The effect of this soil organic compound on growth was studied by growing plants in nutrient culture solution, in soil and in sand.

In culture solutions salicylic aldehyde was very harmful to wheat, corn, cabbage and cow-pea plants, in amounts of 10 parts per million. Amounts from 50 to 100 parts per million killed the plants. The aldehyde was harmful in cultures containing phosphate, nitrate and potash, regardless of whether the salts were used singly or in combinations. The aldehyde in small amounts was also harmful when added to soil and to sand.

Forty-five unproductive and thirty productive soils from various parts of the United States were examined for salicylic aldehyde. Seventeen of the unproductive soils and three of the productive soils contained the aldehyde. The extracted soil aldehyde was tested in water cultures as to its effect on growth and in each case proved harmful.

Mary Louise Foster: *A Comparative Study of the Metabolism of Pneumococcus, Streptococcus, Bacillus lactis erythrogenes and Bacillus anthracoides.*

Two strains of pneumococcus grown at 37°–40° C. on serum with three parts of water showed that proteolysis is progressive, the largest phosphotungstic fraction being found at the highest temperature. Sterilized milk at 37° C., inoculated with streptococcus, bacillus lactis erythrogenes, or bacillus anthracoides showed hydrolysis of the native protein, diamino and monoamino acids being formed. The amount of monoamino acid increased with the time of the interaction.

L. W. Fetzer: *A Biochemical Interpretation of the Inheritance of Acquired Characters.*

W. T. Bovie: *The Chemical Effects of Ultraviolet Light on Albumin.*

Ultra-violet light causes egg white and crystallized egg albumin to coagulate and to give off a peculiar odor similar to the odor of burned hair. Coagulation can be produced while the albumin is cooled in ice water. The albumin is decomposed by the light. Lead-blackening gases are given off. Cystine and hydrogen sulphide are also decomposed. The coagulation and decomposition are produced almost entirely by the ultra-violet light not found in sunlight. Protoplasm is unstable in light of shorter wave-lengths than is found in sunlight. Life as we know it would be unstable in a world unprotected by an atmosphere at least as opaque as ours.

Alfred Dachnowski: *Plant Growth in Relation to Acid and Alkaline Solutions.*

A. P. Mathews: *The Nature of Irritability and the Action of Anesthetics.*

Confirming his earlier work, the author finds that the anesthetics act chemically, not physically, as generally supposed. By means of the method of computing valences in molecules, it is shown that all anesthetics have residual valences by which they may unite with protoplasm. Thus nitrous oxide has six valences, the oxygen having two free valences; the esters, alcohols, aldehydes have free valences on the oxygen; this is also true in the urethane group; in carbon monoxide, the free valences are probably on the carbon; in ether, on the oxygen; in chlorine compounds, on the chlorine; in bromine compounds, on the bromine; in carbon bisulfide and sulphuretted hydrogen, on the sulphur; in the cyanides and nitriles, on the carbon; in the terpenes, benzenes and aliphatic hydrocarbons some of the carbons are hexavalent. The ease of dissociation of the anesthetic from the protoplasm also points to a molecular union. All anesthetics probably unite with hemoglobin, forming molecular unions similar to oxyhemoglobin. The interpretation offered of irritability based on the work of the author, Tashiro and others, is as follows: The irritable compound in most protoplasm is a molecular union with oxygen. This is unstable like oxyhemoglobin, which passes easily to methemoglobin. When stimulated in a variety of ways it passes into firm union, oxidation taking place. This is at the basis of most cell syntheses. The anesthetics act by displacing the oxygen from its molecular union, just as CO displaces O_2 in oxyhemoglobin, the anesthetics uniting by their residual valences in molecular

union with the oxygen receptors. Such compounds can not be oxidized by shock, hence respiration is reduced; conduction which is analogous to an explosion wave of oxidation is blocked; irritability is lost; growth and synthesis stops.

H. C. GORE: *Note on the Volatilization of Sulphuric Acid when Used as a Desiccating Agent in High Vacuum.* (Lantern.)

H. C. GORE: *A Constant Temperature Humidor.* (Lantern.)

H. C. GORE: *Study of the Chemical Changes in the Banana during Ripening with Special Reference to the Transfer of Water from Peel to Pulp.* (Lantern.)

H. C. GORE: *Study of the Effect of Uranyl Acetate and Ammonium Molybdate on the Polarization of l-Malic and d-Tartaric Acids.* (Lantern.)

ARTHUR W. DOX and RAY E. NEIDIG: *Cleavage of Hippuric Acid by Molds.*

The formol-titration method of Sörenson was found admirably adapted to a study of enzymotic cleavage of hippuric acid. All of the mold species examined contained an enzyme capable of hydrolyzing 80 per cent. or more of the hippuric acid in the presence of toluol. The age of the culture (1 to 4 weeks) seemed to have little influence upon the amount of enzyme. The enzyme was produced in all cases in the absence of the corresponding zymolyte from the medium.

P. E. BROWN: *Bacterial Activities and the Rotation of Crops.*

GEORGE PEIRCE: *The Purification of the Esterase from Pig's Liver.*

The esterase is obtained by crushing pig's liver with sand, mixing with water and straining through cloth. The purification is accomplished by dialysis, half saturation with $(NH_4)_2SO_4$, rejection of ppt., complete saturation with $(NH_4)_2SO_4$, and dialysis of a suspension of this ppt. After filtration the solution will hydrolyze 200 times its weight (reckoned as dried material) of ethyl butyrate in 1 hour, the final acidity being $N/100$, the ethyl butyrate solution being about two thirds saturated ($N/28$).

The enzyme is strongly inhibited by NaF, the inhibition being due to an inert compound formed by the enzyme and the NaF. The amount of inhibition followed the mass law. A possible method of working out the maximum molecular weight of the grouping with which the NaF combined was indicated.

R. E. SWAIN and J. P. MITCHELL: *The Determination of Sulphur Dioxide in the Air.*

The sample of air is collected for analysis in a flask of about ten liters' capacity. The latter is fitted with a glass stopper carrying a dropping funnel and a short outlet tube. $N/100$ iodine solution (10 c.c.) and 150 c.c. of water are then added, and the flask and contents shaken vigorously for ten minutes. Stopper and fittings are rinsed off and removed, and $N/100$ arsenious acid added until only a faint brown color remains. The solution is finally rinsed into a titrating flask and the titration finished with starch as an indicator. Results on known amounts of sulphur dioxide indicate an error of less than five parts per million parts of air.

EDWARD KREMERS: *The Methyl and Methylene Ethers of Phenols Found in the Vegetable Kingdom and the Light which they Seem to Throw on Certain Phases of Plant Metabolism.*

The importance which formaldehyde or its hydration product, the methylene glycol, plays in plant metabolism is universally recognized. The minor rôle played by the other reduction products of carbon dioxide has been largely overlooked. The rational classification of the methyl and methylene ethers of the phenols, together with that of glucosidal compounds of the phenols, seems to throw a ray of light on the rôle which these two simple alcohols play in common with the simple sugars.

WM. MANSFIELD CLARK: *The Analogy between the Formation of "Eyes" in Emmental Cheese and Crystal Growth.*

A review of the literature reveals no conclusive evidence that the characteristic holes or "eyes" of Emmental cheese are localized at points of great bacterial growth. The alternative, that the eye-inflating, gas-producing bacteria are more or less generally scattered throughout the whole body of the cheese is confirmed by the comparison of the gas production of eye walls and of solid regions distant from eyes.

That the gas produced by bacteria in gels may separate at points distant from the colonies, and that this gas separates preferably where a preformed bubble is already found has been experimentally demonstrated. Instances are also cited to show that large bubbles grow at the expense of small.

The theoretical reasons are presented as well as the analogy between the formation of gas

bubbles and the growth of raindrops and solid crystals.

From these principles it is deduced that with a rapid gas formation in cheese the gas must necessarily tend to separate at many points, each more or less near to colony growth, while with a slow gas production the gas has time to find its way to points where it may separate from solution most advantageously and then continue to form accretions. It was found by using curd superficially stained with Congo red which outlined each curd particle in the cheese, that "Nissler" holes which are small and rapidly formed were situated both within and between curd particles, while normal eyes universally developed between the curd particles, points long ago described by Bachlor as "weak spots" favorable to eye growth.

F. Alex. McDermott: *Chemiluminescent Reactions with Physiologic Substances.*

The products of the alkaline hydrolysis of peptone and glue, done in the absence of oxygen, give a faint light when oxidized with strong alkaline hydrogen peroxide, and a somewhat brighter light when formaldehyde is added before the peroxide. Urin may be caused to give light in a number of ways, particularly upon the addition first of formaldehyde and then of alkaline hydrogen peroxide. The cause of the latter phenomenon is not known.

F. Alex. McDermott: *A Note on an "Oil Nut," Pyrularia pubera (Buffalo nut).*

The fruit of *Pyrularia pubera* contains about 27 per cent. of oil. The cause of the astringent taste was not located.

O. Riddle: *On the Absorption of Water by Egg Yolk from Egg Albumen.*

SECTION OF INDIA RUBBER CHEMISTRY

D. A. Cutler, *chairman*

Dorris Whipple, *secretary*

Charles P. Fox: *Wild Lettuce Rubber.*

Descriptive notes concerning two well-known Compositæ common throughout central United States and suggesting their possible use as a source of *crude rubber* and *drug.* Characteristics of this rubber, the by-products and methods of obtaining them, are given.

Charles P. Fox: *An Adopted Wiley Extractor for Rubber Extractions.*

Author notes the unsatisfactory service given by the usual forms of extractor used in raw rubber extractions. Paper describes a simple, economical and efficient apparatus for this work.

John B. Tuttle: *The Sampling of Rubber Goods.*

Attention is called to the importance of obtaining proper samples for chemical analysis. Illustrations in support of the argument are given; also precautions regarding care of samples, and a table of the minimum amounts required by the Bureau of Standards for physical and chemical tests.

L. G. Wesson: *Preliminary Note on a New Method for the Direct Determination of Rubber.*

To avoid errors due to variations in the composition of the derivatives of rubber heretofore used in its analysis, the method outlined attempts to estimate rubber by burning its nitrosite, and subsequently weighing the carbon dioxide formed. For the expeditious combustion of the nitrosite, an electric combustion furnace has been developed. Some results for rubber, on both raw and vulcanized samples, are given. The method possibly offers an opportunity for the simultaneous determination of sulphur of vulcanization. Further work is under way.

DIVISION OF PHARMACEUTICAL CHEMISTRY

B. L. Murray, *chairman*

F. R. Eldred, *secretary*

H. T. Graber: *Observations upon the Assay of Digestive Ferments.* (Second paper.)

A. Zimmerman: *Blood Fibrin in the Assay of Pepsin.*

Fred Klein: *Some New Reactions of Peptones and Enzymes.*

Joseph P. Remington: *The United States Pharmacopœia—Progress of the Ninth Revision.*

Changes in the method of revising the book as compared with the revision of previous pharmacopœias. The influence of the Food and Drugs Act in obtaining information from manufacturers about their products. Improvements in preparing the text.

Atherton Seidell: *The Analysis of Thymol Capsules.*

Atherton Seidell: *The Riegler Method for the Determination of Thymol.*

F. O. Taylor: *Interpretation of the U. S. P. Assay Processes.*

This paper deals with the possibility of different interpretations of the assay methods for alkaloidal drugs and their extracts as given in the U. S. P., with particular reference to some specific instances where discrepancies have occurred because of a

different understanding of the assay processes by various chemists. It directs special attention to the difficulties involved in transferring the alkaloid from an aqueous solution to one in chloroform or ether, or from these solvents to an acid aqueous liquid as is regularly done in these assay processes. Also some of the peculiar difficulties involved in the assay of the mydriatic drugs, and differences liable to be caused by variations in the method and time of shaking aqueous liquids with the immiscible solvents, and in the final titration of the alkaloidal residue where this volumetric method is used. Experimental proof is also submitted of the liability to such variations when these processes are applied by different men.

W. D. McAbee: *Patent Medicine Ethics.*

W. A. Pearson: *Ergot.*

L. E. Sayre: *The Recovery of Alkaloids when Precipitated by Alkaloidal Reagents.*

There is, of necessity, an appreciable loss of alkaloid in any analytical process designed for its recovery. A complete recovery is practically impossible. In certain analyses consisting of a separation of alkaloids from dilute solutions, it is frequently desirable to precipitate them by well-known alkaloidal reagents, as a first step in the separation and estimation. The question arises: What is the probable loss of alkaloid by such a preliminary step and subsequent treatment for recovery?

Operating upon four well-known alkaloids with different procedures for their recovery, certain data were obtained and tabulated. The authors feel this may be considered as a fair average of loss, this opinion being based upon a much larger number of experiments than are tabulated.

F. P. Summers and Chas. Earle: *Oxysulphobenzide, its Presence in Commercial Phenolsulphonates.*

In applying the routine tests for phenol upon the various phenolsulphonates of the market, there was obtained an ether-soluble residue which in some of its properties resembled phenol. On further examination it proved to be oxysulphobenzide. This impurity has been found in quantities of 0.1 to 0.4 per cent. It is a white crystalline body melting between 215° and 231° C.

F. P. Summers and H. McCausland: *Boldine, an Alkaloid from Peumus Boldus.*

A brief résumé of the literature on the chemical constituents of *Peumus boldus* is given. The method of producing the alkaloid boldine is described. It is a white crystalline body melting at 185° C. (corrected). Boldine hydrobromide is also described. It is a white crystalline body melting with decomposition at 240° C. Tables of reactions with the various alkaloidal precipitants and other reagents are given. An empirical formula is promised for a subsequent paper.

F. A. Miller and J. W. Meader: *The Alkaloidal Content of Individual Plants of Datura stramonium, D. tatula and other Species and Varieties.*

F. A. Miller and R. N. Reed: *A Study of American-grown Belladonna.*

R. N. Reed and W. J. Rice: *The Stability of Tinctures and Fluid Extracts of Belladonna.*

A. B. Davis: *Improvements in Mercury Gas-Regulators.*

G. H. Meeker and E. L. Maines: *Prevention of Emulsification in Extractions by Immiscible Solvents.* (Second paper.)

Frank R. Eldred: *An Automatic Apparatus for the U. S. P. Pepsin Test.*

W. O. Emery and S. Palkin: *Crystalline Periodides of Antipyrine.*

H. T. Graber: *Laboratory Studies on Malt Extract.*

C. H. Briggs: *The Determination of Uncombined Hydrochloric Acid in Solution Ferric Chloride.*

The total chlorides are determined by titration with silver nitrate in acid solution. The combined chlorides are calculated from the amount of iron present and subtracted from the total chlorides, giving the amount of free hydrochloric acid.

O. A. Beath and Edward Kremers: *An Oleoresin of Pseudotsuga taxifolia (Lam.) Britton.*

A sample of this oleoresin was obtained through the cooperation of the Forest Products Laboratory. Its examination was undertaken with a view of throwing more light, if possible, on the possible sources of the so-called Oregon balsam. The physical and chemical constants of the oleoresin, the volatile oil and the resin were ascertained so far as the limited amount of material permitted.

Edward Kremers: *Some Aspects of Pharmacopœial Revision.*

The conflict between the pharmacopœia as a codex and a scientific treatise is unnecessarily emphasized by the present mode of revision. This conflict and the attitude of certain critics is illustrated by means of data that have come to the attention of the writer in the work in which he is more particularly engaged. The revision of the

U. S. Pharmacopœia in the future should be carried out by a method of publication more in harmony with modern practise.

DIVISION OF INDUSTRIAL CHEMISTS AND CHEMICAL ENGINEERS

G. D. Rosengarten, *chairman*

M. C. Whitaker, *secretary pro tem.*

Carl A. Nowak: *The Training of the Fermentologist.*

The constant demand on the part of the fermentation industries for university-trained men offers a profitable field of work for the young chemist. The future fermentologist should possess considerable specialized training in analytical and research work pertaining to the raw materials entering into these industries. The paper discusses the manner in which such scientific training is provided abroad, in England and on the continent, and points out that while, as yet, there is no such provision made at any of the universities in this country it does not seem improbable that with the financial assistance of the men interested in the fermentation industry this could easily be accomplished.

John Samuel Staudt: *The Training of the Technical Chemist.*

The paper makes a survey of what the training of the technical chemist is at present, and points out what the training of the technical chemist ought to be. A comparison and analogy of the training of the technical chemist is made with that of the civil, mechanical and electrical engineer. The paper reviews technical education as it exists in England, Germany and America, and makes a comparison of the methods in vogue.

In discussing what the training of the technical chemist ought to be, the writer points out what the world demands, and in what respects our present system of technical education is faulty. It advocates a more thorough study in the liberal arts and more cooperation between the university, or technical institution and the industries, favoring a permission of technical students to work for the cooperations during their summer vacations.

Graduate study as a direct continuation after graduation is not favored, but is recommended after a year or two in practise.

Francis C. Frary and M. Gordon Mastin: *The Determination of Zinc in Treated Ties.*

Over nine million railroad ties were preserved by treatment with chloride of zinc in 1911. Practically all these are bought under the specification that they must contain half a pound of zinc chloride per cubic foot. The method of determining the zinc after decomposing the wood of the sample with nitric and sulphuric acids, as generally used, is slow and troublesome, and with red oak ties it appears to be impossible to destroy all the organic matter. This prevents the precipitation of the zinc, and the result is that analysis of such ties will show less than half of the zinc actually present.

The authors have worked out a method of decomposing the wood by fusion with caustic potash and a little saltpeter, which removes every trace of organic matter, and leaves the solution in such a condition that the zinc can be determined by titration with potassium ferrocyanide solution. Accurate results are easily and quickly obtained. Check determinations with shavings from untreated red oak ties, to which known amounts of zinc chloride solution were added, showed that the recovery of the zinc was practically complete.

A. M. Muckenfuss: *Preliminary Report upon a Practical Accelerated Test for Paints and Varnishes.* (Lantern.)

S. W. Parr: *Coal Ash.*

Edward Gudeman: *Analyses of Glucose and Starch Sugars.* (See Agricultural and Food Chemistry.)

Horace C. Porter and Guy B. Taylor: *The Specific Heat of Coal and its Relation to the Presence of Combined Water in the Coal Substance.*

The specific heats of four coals were determined by the method of mixtures with an accuracy of 2 to 3 per cent. The values for dry coal ranged from 0.261 to 0.315, according to the type of coal, within the temperature interval 28°–63° C. A Wyoming sub-bituminous, of 11 per cent. moisture showed a value of 0.370. At higher temperatures the specific heats were higher.

Comparison of the specific heats of dried and undried coal shows the specific heat of the water present to be about 0.72 and indicated thus that the water is present in a state other than that of free superficial moisture. The facts also that heat is developed by the action of water on dry or partially dried coal, and that coal containing water has a vapor pressure considerably below the normal aqueous tension of free water, tend to support the theory of the presence of combined water, although the low vapor tension may possibly be explained also as due to capillarity or adsorption.

OTTO M. SMITH: *Concrete Analysis.*

CHARLES L. PARSONS: *Fuller's Earth—Its Occurrence, Mining, Preparation, Use and Recovery.*

CHARLES L. PARSONS: *The Uranium, Vanadium and Radium Situation.*

C. E. WATERS: *A Simple Gasoline Gas Generator for Sulphur Determinations.*

R. S. McBRIDE and E. R. WEAVER: *The Determination of Sulphate in Ammonium Sulphate with Special Reference to the Determination of Sulphur in Illuminating Gas.*

Four methods for the determination of sulphate in ammonium sulphate solutions such as are obtained in testing of illuminating gas, have been examined and the proper conditions for their use are described. One volumetric and one turbidimetric procedure are given, both of these being rapid and fairly precise methods suitable for general use. It is suggested that the rapid turbidimetric procedure may be used in cement, rubber, iron and steel and other analytical work where an accuracy of one per cent. of the sulphur present is satisfactory.

R. S. McBRIDE and E. R. WEAVER: *The Determination of Sulphur in Illuminating Gas.*

The several forms of apparatus commonly used for the determination of sulphur in illuminating gas have been tested, giving particular attention to the Referees', the Hinman-Jenkins and the new form Elliott apparatus. These three are all capable of giving satisfactory results if properly operated, three important conditions for correct results being: (1) a proper rate of burning the gas, (2) a strongly alkaline atmosphere in the condenser chamber and (3) the elimination of all rubber connections between the burner and condenser.

General Discussion of Industrial Problems

A general experience meeting was held on Thursday morning in which members discussed general industrial problems.

DIVISION OF FERTILIZER CHEMISTRY

Paul Rudnick, *chairman*

J. E. Breckenridge, *secretary*

ANDREW J. PATTEN and WM. C. MARTI: *A Simple Method for Preparing Neutral Ammonium Citrate Solution.*

This method is based upon the reaction observed by Schiff[1] to take place between formaldehyde and ammonium salts, resulting in the liberation of the acid and the formation of hexamethylentetramin, according to the following equation:

$$4C_6H_5(NH_4)_3O_7 + 18CH_2O = 4C_6H_8O_7 + 3CH_2N_4 + 18H_2O.$$

It depends upon the determination of the exact amount of ammonia and anhydrous citric in the solution and establishes the ratio for the neutral solution as 1:3.765.

[1] Liebig's *Annalen der Chemie*, 1901, 319, 76.

J. W. TURRENTINE: *A Survey of the Menhaden Industry.*

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

S. L. Bigelow, *chairman*

R. C. Wells, *secretary*

S. L. BIGELOW: *Some Surface Tension Phenomena.*

O. F. TOWER: *The Oxygen Content of the Atmosphere.*

D. A. MACINNES: *The Rôle of Adsorption in the Catalysis of the Decomposition of Hydrogen Peroxide by Colloidal Platinum.*

O. L. BARNEBEY: *Detection of Cyanides in the Presence of Ferri-, Ferro- and Sulpho-Cyanides.*

When hydrogen sulphide is passed into a dilute ammoniacal copper solution a black precipitate of copper sulphide or a brownish black coloration is imparted to the solution, depending upon the amount of copper present. A cyanide in ammoniacal solution will bleach such a suspension or coloration. By this bleaching a cyanide can be detected. By the amount of standard copper solution bleached an approximate determination of cyanides can be made in the presence of ferri- and sulpho-cyanides. Ferro-cyanides interfere with estimation, but not detection.

ALBERT P. MATTHEWS: *A Method for Determining the Number of Valences in Molecules.*

O. L. BARNEBEY: *The Permanganate Determination of Iron in the Presence of Chlorides.*

The Reinhardt-Zimmerman method for the determination of iron gives the correct result. Sulphuric acid with manganese sulphate, strong solutions of certain sulphates, certain phosphates with phosphoric acid and cerium sulphate with sulphuric acid can be substituted for the usual "manganese solution" employed to prevent the action of hydrochloric acid during titration. Theories proposed for the explanation of the rôle of these "preventive solutions" are discussed.

Edward C. Franklin: *Some New Ammonio Salts.*

Herbert N. McCoy: *The Alpha-ray Activity of a Layer of Radioactive Solid as a Function of its Thickness.*

Herbert N. McCoy: *The Periods of Transformation of Uranium and Thorium.*

Arden R. Johnson: *A Theory of the Origin and Continuance of Optical Activity in Nature without the Assumption of an Asymmetric Form of Energy or "Vital Force."*

James E. Egan and Clarence W. Balke: *Atomic Weight of Yttrium.*

W. E. Ruder: *The Intergranular Cement in Metals.*

An investigation is made of the "cement" material between the grains of an iron-silicon alloy of about 4 per cent. Si content. It was found that this material gave exceedingly large grains under the proper conditions of anneal. These grains were separated in two ways: (1) by heating to near the melting point in H and (2) by electrolysis in a solution of $K_2Cr_2O_7$ (as anode). The first process merely weakens the grain boundaries, which are again reverted to their original strength by firing in a diluted hydrocarbon atmosphere; the second process causes the grain to actually fall apart. From these experiments it is held that the great strength of the intergranular boundaries is due to the presence of certain foreign materials, and not alone to the grain substance in the amorphous phase.

William D. Harkins, H. M. Paine and R. D. Mullinix: *The Intermediate Ion Hypotheses and the Solubility of Salts of Higher Types.* (Lantern.)

Stuart J. Bates: *The Significance of the Exponent in Storch's Equation.*

For di-ionic electrolytes the exponent in Storch's equation, $C_i^n/C_u = K$, has the significance

$$n = 2\frac{d\pi_i}{dC_i} \Big/ \frac{d\pi_u}{dC_u}$$

where C_i and π_i are the concentration and the osmotic pressure, respectively, of the ions and C_u and π_u those of the undissociated molecules. From freezing point and conductance data it is possible to calculate the osmotic pressure of the ions and also that of the undissociated molecule as a function of the concentration. For KCl from 0.05 N to 0.5 N the osmotic pressure of the ions is 4 to 5 per cent. less than that calculated from the gas laws, while that for the undissociated molecules is 30 to 45 per cent. greater.

Stuart J. Bates: *The Calculation of Equivalent Conductance at Infinite Dilutions.*

A mathematical analysis of the methods employed by Kohlrausch and by Noyes for calculating the equivalent conductance at infinite dilution (Λ_0) shows that these assume that the expression for the "ionization constant" $(C\gamma)^2/(1-\gamma)C$ becomes zero at zero concentration. A method is developed based upon a consideration of the exponent in Storch's equation (cf. above abstract) which sets limits between which the value of Λ_0 must lie. A graphic empirical method for determining Λ_0 values was also developed. In general the values thus obtained lie within, while those calculated by Kohlrausch lie without the theoretical limits. The final adjusted Λ_0 values are smaller than those generally employed, for un-univalent salts by about 0.4 per cent., for uni-bivalent salts about 0.7 per cent. and for bi-bivalent salts about 1.7 per cent.

Harry N. Holmes: *Electrostenolysis.*

Arden R. Johnson and B. W. Hammar: *Design for Specific Heat Apparatus (Electrothermal).*

J. Culver Hartzell: *The Relation of Geochemistry to Proposed Standard Types of Potable Waters.*

The author considered the geochemistry of waters and distinguished between voluntary or esthetic tolerance and involuntary or human system tolerance. He also considered bacterial count and put emphasis on *B. coli.* Comparative tables from the sanitary and geochemical standpoints were given. The author recognizes the impracticability of standard types of potable waters for universal application; but is strongly impressed with the practicability and necessity of regional standard types to which all municipalities could and should bring their domestic and industrial supplies. Cincinnati, New Orleans and Fargo were cited; the latter showing the most striking results from a most difficult water. Regional types of standard waters were proposed.

E. H. Archibald: *The Teaching of Quantitative Analysis.*

J. W. Turrentine: *The Structure of the Trinitride Radical.*

R. H. Brownlee and R. H. Uhlinger: *Demonstration of the Zeiss Gas Interferometer for the Estimation of Minute Traces of Gases.*

Joel H. Hildebrand: *The Constitution of Certain Liquid Amalgams.*

The formula given in a previous publication for the E.M.F. of liquid amalgam concentration cells was integrated exactly and applied to those amalgams which have thus far been investigated with sufficient accuracy, with the following results:

1. The results of E.M.F. and vapor pressure measurements with zinc amalgams are shown to be in very good agreement. In the light of the vapor-pressure law this is shown to indicate that in these amalgams the zinc exists uncombined with the mercury but associated according to the equation

$$2Zn = Zn_2 + 2{,}400 \text{ joules.}$$

The equilibrium constant of this reaction, and accordingly the degree of association at different dilutions, is given, and shown to be in excellent agreement with the measurements of E.M.F. and its temperature coefficient.

2. With lead and tin amalgams the same formula relating E.M.F. with constitution as was deduced for zinc is shown to apply, but with a different constant corresponding to a much greater degree of association.

3. The measurements on thallium amalgams are shown to correspond to the formula derived for the cases where combination exists between the solute and the mercury. The compound indicated in this case is $TlHg_6$, which gives evidence of breaking up into some simpler compound, probably $TlHg_2$ in the more concentrated amalgams.

4. Indium amalgams, on applying the same formula, seem to contain $InHg_4$, breaking down into some simpler compound in the more concentrated amalgams.

5. Cadmium amalgams seem to contain both free Cd and the compound CdHg, in proportions depending on the law of mass action. The E.M.F. formula is derived for this case and shown to give the observed values of E.M.F. very closely. The per cent. of the cadmium as CdHg is calculated. In the most dilute amalgams two thirds of the cadmium is present as CdHg.

The validity of the formula is discussed and its value is pointed out in determining the constitution of metallic solutions and as a means of investigating the present unknown factors influencing the vapor pressure of solutions.

ALBERT D. BROKAW: *The Precipitation of Gold by Manganous Salts.*

Ordinary solutions of gold chloride are rather strongly acid, and from such solutions manganous salts do not precipitate gold even when high concentrations are used and the solutions kept boiling for some little time. When the acidity is sufficiently reduced manganese dioxide and gold are precipitated simultaneously, probably according to some such equation as follows:

$$3MnCl_2 + 2AuCl_3 + 6H_2O \rightarrow 3MnO_2 + 2Au + 12HCl.$$

A suggested explanation is that minute amounts of $MnCl_4$ are formed and this substance hydrolyzes when the acidity falls below a certain concentration, giving a precipitation of hydrated manganese dioxide. In more acid solution the acidity suppresses hydrolysis and no reaction takes place.

HANS MANNHARDT: *Tetravalent (?) Nitrogen and Di-Valent (?) Chlorine.*

H. V. TARTAR: *On the Reaction of Sulphur with Potassium Hydroxid in Aqueous Solutions.*

Methods have been worked out in connection with some investigations on the lime-sulphur spray which enable one to ascertain the primary reaction taking place between sulphur and any of the hydroxids of the alkali metals in aqueous solution. Experiments were tried using sulphur and potassium hydroxid in different amounts and in solutions of varying concentration. The results show that the primary reaction of sulphur with potassium hydroxide in aqueous solution is as represented by the following equation:

$$6KOH + 8S = 2K_2S_3K_2S_2O_3H_2O.$$

FRITZ FRIEDRICHS: *Binary Systems. I. Hydrazine, Ammonia.*

In this research, which constitutes the first chapter of an extended investigation of the nature of supplementary valence, the relation of ammonia to hydrazine, the next member of the hydro-nitrogen series, has been studied.

A dilatometric study of the purest hydrazine (shown by analysis to contain 100 per cent. N_2H_4 and subsequently distilled twice in vacuo over pure barium oxide directly into the dilatometer) showed a unary melting point of $+3.3°$, indicating a very high degree of purity. This pure hydrazine forms no compounds with anhydrous ammonia. The presence of the slightest trace of water, however, leads to the formation of mixed crystals. The complete pressure, temperature, concentration diagram of this system was investigated. The three-phase surface shows a pressure maximum of 680 mm. at $-19°$, the solubility line a eutectic at $-81°$ and a concentration of 85 per cent. NH_3.

Fritz Friedrichs: *Binary Systems. II. Ammonium Trinitride, Ammonia.*

Ammonium trinitride forms with ammonia three compounds containing, respectively, 1, 2 and 4 molecules of ammonia. All of these ammonates show metastable melting points. The inversion point of the diammonate into saturated solution of the anammonous salt is at $-8.5°$, that of the tetrammonate into saturated solution of the diammonate is at $-71°$, and the eutectic is at $-87°$ with a concentration of 75 per cent. NH_3. The remarkable circumstance that the first two of these ammonates $NH_4N_3 \cdot NH_3$ and $NH_4N_3 \cdot 2NH_3$ were never observed to exist together seems to point toward a tautomerism of hydronitric acid. It is not impossible then that the compound may under certain conditions have the older ring formula and under others the chain formula independently suggested by Angeli, Thiele and Turrentine.

Fritz Friedrichs: *Binary Systems.* III. *Ammonium Bromide, Ammonia.*

In extension of the work of Roozeboom, who studied a limited portion of this system, ammonates containing, respectively, 1, 3, 6, 9 and 18 molecules of ammonia were shown to exist and the boundaries of their fields were established. All of the three ammonates with the exception of the tri- and the octodecammonate possess metastable melting points. The stable melting points of the two just named were found at $+9.5°$ and $-79°$, respectively. Inversion points were found for the transition of $NH_4Br \cdot NH_3$ into saturated solution of anammonous salt at $+36°$, of $NH_4Br \cdot 3NH_3$ into saturated solution of $NH_4Br \cdot NH_3$ at $+6.5°$, of $NH_4Br \cdot 6NH_3$ into saturated solution of $NH_4Br \cdot 3NH_3$ at $-69.5°$, of $NH_4Br \cdot 9NH_3$ into saturated solution of $NH_4Br \cdot 6NH_3$ at $-72°$. The zone of the saturated solution of the triammonate shows a pressure maximum of 1,600 mm. at $+4°$.

As may be seen from the foregoing examples the ammonates are entirely analogous with the hydrates contrary to the recently expressed opinion of Fritz Ephraim (*Zeitschr. phys. Ch.*, 81: 539–542, 1913), who on the basis of an investigation upon the ammonates of certain metallic salts (all of which happened to be insoluble in liquid ammonia) believed that he had discovered a fundamental difference between ammonates and hydrates, since the former apparently showed no inversion points or definite fields of existence.

Charles James and E. H. Holden: *Sulphates of Yttrium.*

W. A. Noyes: *Nitro-Nitrogen Trichloride an Electromer of Ammono-Nitrogen Trichloride.*

Ordinary, or ammono-nitrogen trichloride hydrolyzes to ammonia and water. An attempt is being made to secure nitro-nitrogen trichloride, which should hydrolyze normally to nitrous acid and water. To prepare the compound a mixture of nitrosyl chloride, NOCl, and phosphorus pentachloride is passed through a porcelain tube heated to 1000°–1200° and containing a little platinum. A mixture of gases which can be condensed with a freezing mixture or by cooling with liquid air is obtained. The analyses indicate the presence of a trace of phosphorus oxychloride, a small amount of silicon tetrachloride, nitrosyl chloride, free chlorine and, in some cases, about ten per cent. of nitro-nitrogen trichloride.

C. L. Parsons,
Secretary

SOCIETIES AND ACADEMIES

THE AMERICAN PHILOSOPHICAL SOCIETY

Mr. Herbert E. Ives read a paper before the society on April 4, 1913, on "Illuminants—Present and Future." Modern illuminants are interesting as applications of radiation laws and the science of spectroscopy. The earlier illuminants, such as oil, the candle, the gas flame, the carbon filament electric lamp, are approximations to black-body radiation. Increased efficiency is with these dependent on the attainment of very high temperatures. More recent illuminants possess higher efficiency owing to selective radiation, in accordance with Kirchhof's law for selectively reflecting or transmitting bodies. Thereby their radiation is relatively more intense in the visible spectrum. This is the case in the Welsbach mantle and the tungsten filament. Another class of selective radiation is met in non-temperature or luminescent sources, where isolated spectrum lines or bands are the source of the light. The mercury vapor lamp falls in this class. The illuminants of the future will be marked by greater efficiency, which may be attained through selective radiation. Whether this will be brought about by the use of gaseous energy or electrical, or through little understood chemical processes such as the firefly exemplifies, is of course as yet unknown. Calculations show that if there were none of the present enormous losses in transforming the energy of coal into light something like 1,200 times as much light could be obtained for the same consumption.

SCIENCE

FRIDAY, MAY 9, 1913

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

INTERNATIONAL COOPERATION IN RESEARCH[1]

THE intellectual activity of the world, scientific, literary or emotional, passes alternately through fertile and through barren periods. Each fertile period has its characteristic peculiarities and though any one generation may not be competent to form a just estimate of its powers and effects, it is able to compare the fruits of its own labors with the harvest of its predecessors. You will probably agree with me that our age is distinguished by having disclosed a vast array of facts which take us nearer to the infinitesimal structure of matter and which reach further into the infinite design of the universe, than the boldest flight of imagination could have foreseen half a century ago. But we do not flatter ourselves that the intellect of our time, judged by the power of individuals, is exceptionally great. No doubt, men of commanding genius are still with us, but they are not more numerous or more original than in former times. What then is the peculiarity that has produced such great results? In my opinion what has been accomplished is due in great part to the spread of higher education, which has evolved an army of competent investigators possessing enthusiasm for research which now, for the first time, is led into useful paths by the few great minds, whose powers thus receive a wider range and become more productive. It is in this that our great strength lies.

[1] Address delivered before the National Academy of Sciences on the occasion of the semi-centennial celebration of its foundation.

The functions of an organization devoted to research are to take full advantage of all available mental resources. Intellect can not be artificially created nor can originality be taught, but whatever intellect and originality exist, may be directed into fertile channels, so that those who have the gift of connecting facts shall not fail because the facts are not available.

The advance of science demands that experiment or observation and theoretical discussion should advance in parallel lines. Without organization, one of the teams on whose joint exertions the advance depends is likely to outrun the other. Thus Newton, when he had formulated his law of gravitation, which connects the orbit of the moon with the acceleration of falling bodies, did not publish his discovery for many years, because he could not verify his theory as closely as he desired. It was only after the French Academy had accurately measured an arc of meridian and had discovered a substantial error in previous measurements that Newton's law of gravitation could be said to be proved. In this case theory had gone ahead of observation; but examples of the opposite kind will not be wanting so long as we have observers concerned entirely with the accumulation of data, content to leave discussion to the dim future. It is one of the objects of organizing science to bring the two factors to bear on each other.

International cooperation in research is necessary because scientific inquiries can not be divided into compartments limited by political boundaries. The very language which we use to express our thoughts is tied down by conventions, some of which we have absorbed as students, but which in the case of new branches of learning have formally to be agreed upon. Our measurements—and all accurate science depends on measurements—have to be expressed in units, and how are these units to be fixed except by agreement? While this will be acknowledged by every one, it is not equally recognized how much our present refinements in scientific research depend on organized efforts. Whether these efforts should be concentrated in a single laboratory or confined within one political unit or carried out by the combined scientific community of the world, mainly depends on the nature of the problem.

It is not my purpose to trace in detail the history of international problems and international organizations; but, rather, to show the great variety of problems in which useful results have already been achieved by international cooperation, and to bring the lessons of the past years to bear on the future.

I divide international cooperation into three categories:

1. Agreement on standards and units of measurement.

2. The distribution of work bearing on the same problem, between different nations, for the purpose of economizing time and expenditure.

3. The investigation of problems which can not be solved unless observations made with identical or similar instruments are obtained from different parts of the world and the records published in a homogeneous form.

I think all are agreed as to the question of units and I need not detain you by giving you an account of the various international conferences which have been held and agreements which have been arrived at on these matters.

As regards problems of the second category, they are those which deal mainly with the cosmos, as a whole, because their solution depends so much on the collection of statistics which exceeds the powers of

individuals or even of single nations. A few examples may illustrate what has already been accomplished. First, and foremost, we have the great star catalogue, initiated at an international congress twenty-five years ago, when eighteen observatories combined to divide the work, each taking a number of zones in the heavens.

The importance of this work will be plain to every one, and we must regret that it is still so far from being completed.

As it is not my intention simply to point out the merits of international work, but also to point out its difficulties, a few words may be said which are not intended as criticism, but which may serve to point out the weakness which arises when there is no central authority which lives longer than the single individual can expect to live.

Pioneers will always be found to initiate a work, but in time they die or retire from office; others take their places, and if these become more interested in fresh problems, the work suffers unless it is effectively impressed on their attention by some permanent body. Where to find such a central body, whose main functions would be to endow an undertaking with sufficient inertia to carry it over periods in which the work may seem to be a drudgery, is a matter which deserves careful consideration.

The completion of the "Star Catalogue," which has given rise to these remarks, is only the beginning of an even greater piece of work. When we have determined the positions and magnitude of stars at any one time, we have only taken the first step towards solving the main problem, and must proceed to measure the proper motions, the parallaxes, and also map the spectra. This work is so vast that all hope to accomplish it within reasonable limits is difficult and has to be abandoned unless our statistical ambitions are lowered, and instead of taking the complete sphere of the heavens we select restricted but typical areas for detailed examination. This has been done on the initiative of Professor Kapteyn, who has secured a sufficient number of voluntary associates who are now carrying out a combined undertaking which has already yielded results of the greatest importance, and you will hear something more of this work from his own lips.

Now the essence of work of this kind consists in shortening the time required to accomplish an extensive task by dividing it among a number of persons. If the work is purely statistical it may be complete in itself, and the published records become then available to any one who requires them. In other cases, the observations may have to be collected by a central authority and treated by recognized methods of statistics or analysis before they become useful to the scientific public. While it is generally the observational portion of the work that is subdivided and the discussion that is centralized, the reverse is the case in the proposal made by Professor Pickering—that one central observatory in a favorable position should furnish photographs in sufficient numbers and distribute them among astronomers all over the world, to be measured and discussed.

Finally, a great undertaking of quite a different character—the "International Catalogue of Scientific Literature"—must be classed in the same category. This catalogue has arisen out of a desire to classify the scientific literature of the world, so as to enable any one who desires to study a certain subject to find out quickly all previous researches relating to it. Practically all nations in which scientific work is carried out have united, each

collecting its own data and forwarding it to the central bureau in London.

I can not pass away from this type of international cooperation without expressing regret that a proposal which was made by the late Professor Simon Newcomb has not been adopted hitherto. When the first program of the Carnegie Institution of Washington was being discussed, he proposed that there should be some central computing bureau established at one place where accumulated data of observation, which required scientific treatment, could be discussed and treated in that way. The number of instances which have come to my own notice within the last few years, in which the existence of such a bureau would have been of the greatest assistance to the progress of science is considerable; and I feel very little doubt that others have also felt the want.

The problems which fall into the third category are mainly those belonging to the important and much neglected subject of geophysics. The time is past when we could separate the physics of the laboratory from that of the earth, and that again from the physics of the universe. The experimenter who now studies the structure of the atom must keep an eye on the sun and stars in order to detect whether celestial observations destroy his theories or give them strength.

Atmospheric electricity and terrestrial magnetism, treated too long as isolated phenomena may give us hints on hitherto unknown properties of matter. A meteorologist, finding out at last that space has three dimensions, and that the motion of air is governed by the laws of mechanics, has converted what hitherto has been a sport into a science.

Before enumerating the international associations which are dealing with these problems of geophysics, let us say a few words as to the problems themselves.

We have, first, to study the shape of the earth and the variations in the gravitational forces which are observed on its surface. We have further to take account of the secular variations of level and of the more or less violent disturbances which accompany earthquakes and earth tremors. By comparing the indications of instruments placed in different localities, we can deduce the rate of propagation over the earth and through the earth of the seismic waves. This yields us important information on the physical properties or material composing the interior of the earth. The cause of terrestrial magnetism is at present unknown, and we have no means at our disposal to attack the problem directly, but the study of the diurnal and secular variations may give us a clue, and deserves our closest attention.

In a similar way, the study of the higher atmosphere and of the high electric conductivity which the air is now known to possess at heights which we can not reach, is also a subject which can only be studied by combined efforts. How are these questions dealt with at present?

We have, first, an International Association of Geodetics, which is an exceedingly efficient body, with a bureau at Potsdam, under Professor Helmert. That association is successful, perhaps, partly because its work has been facilitated in that it had to build on virgin soil. Nothing had been done, to a very great extent at any rate, internationally before that association came into being. On the other hand, we have the International Association of Seismology, a related subject, which was only founded at the beginning of the present century, with a central bureau at Strassburg. This association had to overcome more serious difficulties. It entered into the field when there was already a less expensive organization in existence, which had been originated by Professor Milne

and was directed by a committee of the British Association. The question of instruments also presented peculiar difficulties, which it is hoped may soon be overcome.

As regards terrestrial magnetism, I have only a few words to say.

Through the magnificent efforts of the Carnegie Institution of Washington, we are at last likely to have a satisfactory magnetic survey of the world, but important as the results obtained by Professor Bauer in the *Carnegie* will prove to be, they will have to be supplemented by systematic observations of the variations of the magnetic forces at a number of fixed stations. Many such stations are in existence, though they are very irregularly distributed over the surface of the earth.

In this subject, almost more than in any other, an international agreement on the manner in which the records are to be treated and published is essential, and it is much to be regretted that the attempts that have been made to reach such agreements have not met with greater success. There are, no doubt, peculiar difficulties due to differences in the organization of the magnetic services.

Methods have developed independently in different countries, and there is a natural but regrettable reluctance to alter an instrumental detail or a peculiarity in treating the observation until the necessity of the change has been demonstrated. But that can never be done, because practically all methods are equally good. What is bad is that they differ. Almost any one of these methods could be adopted with advantage anywhere; so that a discussion of which of the methods is better than the other is futile. The first essential then is that in every place on earth the same methods should be adopted, because the least difference in them may cause important errors in the deductions when they come to be compared with each other.

The only body which at present deals systematically with the records of terrestrial magnetism is a sub-committee of the Meeting of Directors of Meteorological Observations. The Directors of Meteorological Observations meeting at intervals have appointed a certain number of sub-committees dealing with a certain number of subjects. Some of these overlap other associations already. So that, for example, the question of solar radiation falls partly under that sub-committee of the directors of meteorological observations and also under the International Solar Union, a union which has been founded by your foreign secretary, Professor Hale.

The present international organizations differ considerably in the manner in which their expenditure is provided for. The International Geodetic Association, the Association of Seismology and the International Bureau of Standards are directly supported by the governments, the contributions depending upon the population of each country and amounting, for the larger ones to—I need not give you the figures now. They are of no particular interest.

The "International Catalogue of Scientific Literature" is a very costly undertaking, and that is provided for by each country guaranteeing the sale of a certain number of copies; a capital fund having been paid to start the organization by the Royal Society of London.

In the case of the great "Star Catalogue," each observatory is responsible for its own expenditure. The four French observatories have received government contributions amounting together to over $500,000. In England a much smaller sum has been given, and in other countries the

work has languished a good deal because sufficient funds were not available.

The Solar Union has no funds whatsoever and is even unable to pay for its own publications. Sufficient has been said to show how wide a range is already covered by international research. Further extensions of the work are constantly being called for, and we are brought face to face with the problem that separate associations can not be multiplied indefinitely without introducing difficulties which, as their number increases, endanger the objects which they are intended to serve. Apart from the overlapping of interests and questions of finance, the time spent in correspondence and administration is already serious. The nature of the problems suitable to be dealt with by international efforts is such that the same persons are generally interested in several of them, and the meetings succeed each other so rapidly as to become a serious tax on the time of those who attend them and some who used to look with favor on international work are beginning to be frightened.

Perhaps we may look forward to some arrangement to combine the meetings of the different associations in the manner of the different sections of the British Association, for instance. But this would require some central authority to act as a bond between the bodies which at present are separate and independent.

Economy of working, both financial and administrative, points in the same direction, and we are driven to the conclusion—and that, I think, I should like to make the moral of this paper—that the present policy of establishing a separate association for each new extension of international work should be reconsidered and an effort made to economize time in working and administration by some larger scheme, including the various separate international institutions on related and similar subjects.

Realizing that it is necessary to take some action in this direction, yet perhaps not understanding correctly why the action is necessary, an ambitious undertaking has been evolved in Belgium, where it is proposed to erect an office uniting international associations, whatever their object or character may be. The promoters have drawn up their statutes, one general congress has already been held, and another is now being organized. No success can, however, be expected from a scheme launched by a self-constituted and irresponsible body, unless its program commands general respect.

Is this the case in the present instance?

I do not know whether you realize the number of associations which exist. I shall not call them "international associations," but associations which call themselves international. The number to be united in this Belgium scheme is 279, and each of them, if I understand the proposals correctly, may have an office in a large building to be erected for the purpose. If you read through the list of these associations, I do not know what your feeling would be, but I can describe to you what mine has been; and it is exactly like that which I should have if I were to enter a museum, and find, side by side, the Venus of Milo, a living tiger, a collection of rare manuscripts and sanitary appliances. You will be interested to hear that, amongst the institutions which are to be provided for in this building, is the International Bureau of American Republics; but it is also intended to include "The International Congress for Providing Cheap Lodgings." Any one who enters the building and tries to find the particular room to which he wants to go has to ask the man in charge.

You can imagine this kind of a conversation taking place:

Is this the International Union of Friends of Young Girls?

No, but it is the International Congress of Commercial Travelers.

The architect, no doubt, will do his best to group together associations relating to the same subjects, and it would be interesting to pass through the corridors devoted to all the religious and irreligious societies that take the name of "international." If a humorist were to exchange the name plates over the doors, the mathematician who has traveled all the way from Australia to attend the "International Congress for Promoting the Study of Quaternions" might find himself in the room reserved for the "International Union of Woman Suffrage," and a member of the Association of Seismology might be mixed up with the "Association to Prevent the Abuse of Alcohol."

I do not like to throw ridicule on what is obviously a well-meant effort, but however much our sympathy may extend to each of these objects separately, no good purpose is served by inventing a connecting link between incommensurate objects, such as solar research and the proper observance of Sundays.

Our work is sufficiently difficult, if we confine ourselves to scientific methods. It nevertheless remains true that it is desirable to establish some central authority which can act as a connecting link between different associations. What should its functions be? It is the essence of all international combinations that they depend entirely on moral force and have no power to impose their decisions. A central authority must therefore be content with offering advice, with the conviction that, if the advice is sound, it will be accepted. Though the existing associations would tolerate no interference with their independence, they would doubtless consider with care any suggestions made to them in the interests of science by an authoritative body. Our problem is therefore to find an authority of sufficient eminence to be generally looked upon with confidence and who could also act as adviser to different governments when they are asked to financially support some fresh undertaking. That is one of the most serious difficulties of the present time. There is a new international undertaking proposed almost every year, and application is made to the different governments for support and money. What is the government to do? To whom is the government to go for advice whether such an undertaking is worthy of support or not? My solution of that question is this: In the International Association of Academies we possess indeed a body fulfilling all the requirements of such a central authority, provided the individual academies constituting the association are willing to undertake the task. The Association of Academies was founded at a conference held at Wiesbaden on October 9 and 10, 1899, the National Academy of the United States being represented by Professors Newcomb and Bowditch. The paragraph of its statutes which were adopted at a meeting held in Paris in 1901 relating to the functions of the association runs as follows:

The object of the association is to prepare and promote scientific work of general interest which has been submitted to it by one of the associated academies, and to facilitate in a general manner scientific intercourse between different nations.

From its origin the association claimed an advisory voice in new international undertakings, and at the meeting held in London in 1904 the following resolution was passed with one dissenting voice:

That the initiation of any new international organization to be maintained by subventions from

different states demands careful previous examination into the value and objects of such organizations, and that it is desirable that proposals to establish such organization should be considered by the International Association of Academies before definite action is taken.

After a period of activity ranging over about twelve years it may be useful to review the work which has been accomplished, but I shall confine myself to the record of its section of science, remarking only that the section of letters has also much important work in hand.

The powers of the association are purely advisory; it has no funds at its disposal and for this reason alone is unable to initiate or support any scientific enterprise unless the individual academies provide the expenditure, as is being done, for instance, in the publication of Leibnitz's works, which has been undertaken by the academies of Berlin and Paris jointly. A complete map of the moon with its features named according to an agreed scheme is in process of preparation and is welcomed by students of the lunar surface. Among the subjects which have been treated, the excellent work done by an autonomous committee appointed to investigate the functions of the brain should also be referred to; and there are a number of various committees which have done good work.

In many cases the association has been called upon to express a favorable opinion on the importance of some international scheme which is independently being pressed upon the consideration of one or more governments. To deliver a platonic blessing is so gratifying a task that applications for it are not perhaps always scrutinized with sufficient care, though I admit that it is better to support a doubtful enterprise than to risk stopping a good one.

The association has been most successful when it has used its influence to press important scientific objects on the attention of their governments. It is in part at any rate due to their recommendation that money was found for the measurement of the great arc of meridian, which, covering 105 degrees, stretches through Russia and Roumania and continues through Asia Minor and western Africa, to the Cape of Good Hope. This is a continuous arc of meridian reaching from the north of Russia to the Cape of Good Hope in which a number of governments—the British government, the German government, the Russian government and the Turkish government—are involved, which is in process already, and is really nearing completion.

It has become the practise during recent years that international organizations established independently place themselves under the protection of the Association of Academies, to which they report periodically. Though the academies exercise no control over such bodies they stand to them as a reserve power willing to help when required.

In all these respects the association has fulfilled the intention of its founders, but has it left its mark to any appreciable extent on the progress of science? Without wishing to underrate the good that this body has done in the past I do not think I stand alone in hoping for a wider activity in the future, and I doubt whether it will long maintain its vitality unless it extends its ambitions as it passes from the age of youth to that of manhood. This is a critical period in its history, and much will depend on the policy it will adopt on a question which may still be kept in abeyance for a short time, but which will have to be faced before long.

An international organization which has no central office and is not domiciled in

any country is not a legally constituted body. It possesses no property. It can not accept gifts or legacies. The question has been repeatedly raised whether it is desirable to remove this restriction and to establish the association on a legal foundation. For this purpose it would have to place itself under the laws of some one country, and the selection of that country complicates the decision on the main issue, as national consideration and perhaps to some extent national jealousies have to be taken into account.

To clear our minds, let us separate the two issues, that of the power to hold property and that of a permanent domicile. Each academy knows from its own experience that though individual research may often be carried out at a small cost an organized investigation demands funds which become considerable when its range is wide. It is therefore just the type of work that an international organization is best fitted to undertake which demands the greatest amount of assistance.

The question to be faced is this:

Shall our International Association be forever content to exercise a purely platonic patronage, or shall it take an active part in promoting research? If it chooses the latter course it seems to me to be indispensable that it should have funds at its disposal.

I advocate the bolder policy on two grounds: Firstly, international research is most logically administered and paid for by international funds, and, secondly, it seems to me that a purely moral support can not, in the long run, remain effective. The existing special associations, as I have already stated, must retain their complete independence, and it is not likely that it will ever be desirable that the Association of Academies should undertake any work in which financial support is expected to extend over a considerable period; but when promising enterprises are in their experimental stages, funds are often most urgently required and most difficult to obtain.

It is here that an international body, having an independent income, could most efficiently step in to support meritorious enterprises during the few critical years until they can be either established on a permanent basis or have completed their work.

I recognize, of course, the weight of certain objections which have been raised, but I think we must run the risk all the same, for my experience teaches me that there is seldom any vitality without antagonism; and the main ground of objection is that we are going on so nicely, we never disagree and therefore we had better remain as we are. But after all, our progress is only obtained by those having differences of opinion coming together and adjusting their differences.

Even should the general opinion be against me, and if it were definitely decided that the International Association of Academies should forever maintain its present state of poverty, the establishment of a domicile on a moderate scale will have to be considered as an independent issue. It might be mentioned that in the original proposals of the Berlin Academy, they intended that there should be not only a central bureau but an organ, published monthly or quarterly, giving an account of the work done by any one academy that would interest the other academies.

The policy which the International Association of Academies will adopt on these questions is one of the most vital importance, for not only will the future of international work depend on the course

taken, but the reputation and influence of the academies themselves will, I am convinced, be seriously affected by the decision.

It is with the greatest hesitation and with much diffidence that I now approach the concluding portion of my discourse, for I am oppressed by the fear that my remarks may be taken as an unnecessary interference in the concern of others. But the issue is too serious to let that prevent my expressing an opinion which is based on a deep, and I believe impartial conviction.

The academies, royal societies, or whatever name they are called by, have been founded at different times in accordance with the varying requirements of their countries. They value their historical traditions above everything; some are over two hundred years old, others of recent growth, and their constitutions differ in many respects. But whatever their constitution and their history may be, they must be judged by this same test: Do they fulfill their obligations, which for all of them, I take it, are those defined in the charter of the Royal Society as "The promotion of natural knowledge." Do they embody in themselves the promotive power of the scientific efforts of their country, or have they fallen a prey to the dangers, which more especially beset the older institutions, of crystallising into an aristocracy of science, recruited from those who in the natural course of growing maturity are ceasing to be active workers and constitute themselves to be the judges of the work of others? The dead weight of such a society brought to bear discretely on the exuberance of youth may have its uses, but it remains a dead weight just the same. It should act as a brake on a too fanciful imagination, but it can take no share in any real progress. If the academies are to fit themselves for the formation of a really strong and fruit-bearing association, they must be bodies which, animated, as all of them now are, by the highest and noblest ideals, strive at the same time to represent what is best and most progressive in the scientific life within their range of influence.

Each country must solve its own difficulties, but in addressing your national academy which, though it holds to-day its first jubilee, may still be called youthful, I may be forgiven if I remind you that, while the older institutions may offer you much that deserves to be admired and perhaps be imitated, you must not mistake the signs of gray hairs for the stamp of an enviable dignity.

This, then, is my final summary. Ours is an age of organization presenting many problems that can not be confined within political boundaries. The demands of science have already called into existence separate international associations, which are efficiently performing their duties. Nevertheless the continued increase of their number is beginning to cause inconvenience and is likely to hamper future developments unless they can be united by some bond intended to coordinate their work. The International Association of Academies stands out as a natural body, fit to act as a central advisory authority. To exercise that authority effectively, the academies must individually recognize their obligations to be truly representative of the most healthy and vigorous portion of the scientific life of their country. It is because I believe in the vitality of the academies and in the power which an increased responsibility will give them to check the danger of stagnation to which ancient and dignified bodies are exposed, that I advocate the extension of their activity and the

more vigorous exercise of the dormant power which resides in the union of the illustrious bodies which together constitute the International Association of Academies.

ARTHUR SCHUSTER

ROYAL SOCIETY OF LONDON

SIR WILLIAM OSLER'S SILLIMAN LECTURES

SIR WILLIAM OSLER delivered the first of his six lectures on the "Evolution of Modern Medicine" on the Silliman foundation at Yale University on Monday afternoon, April 21. The last lecture was delivered on the 28 ult.

In his first lecture, according to the report in the *Yale Alumni Weekly*, Dr. Osler dealt with the origin of medicine in primitive man and its relation to magic and religion. Certain special practises, such as trephining, were described and illustrated by the lecturer. Egyptian medicine was considered in its three important aspects—magic, the use of animal extracts, and the specialized modes of practise recorded in the famous Ebers, Hearst and Berlin papyri. Divination, particularly by inspection of the liver, astrology and the Hammurabi code, were taken as illustrating the special features of Assyrian and Babylonian medicine. The extension of astrology was traced through Greece and Rome. Among the Hebrews the excellent hygienic regulations were discussed and brief reference was made to the miraculous healing in the New Testament. Dr. Osler showed that the character of ancient medicine may be studied today in China, where charms, enchantments and death-banishing herbs are universally employed.

In the second lecture Professor Osler dealt with the beginnings of science in Greece, dealing first with the nature philosophers of Ionia and south Italy, whose contributions to medicine, while not numerous, were of great importance as influencing the thought of subsequent workers. The physicians of this school were independent of the Osculapian cult, the growth of which he then sketched as met with at Epidaurus and Cos. The work of Hippocrates was discussed and his fundamental proposition that disease was a natural phenomenon to be studied. The high ethical character of Greek medicine was illustrated by the famous oath of Hippocrates. The rise of the Alexandrian School and the study of human anatomy was then considered, and the high-water mark of the period was reached in Galen of Pergamus, whose life and work were described.

In the third of his lectures he treated medieval medicine. He traced the stream of Greek medicine through the three channels in the middle ages—the first continuous Greek tradition in south Italy, which found its highest development in the School of Salernum; secondly, through the Byzantine sources; thirdly, through the Arabs, who by the ninth century had bad translated for them all of the Greek writers. From the Spanish translators of the thirteenth century, from Salernum, and by the dispersion of learned Greeks with their manuscript after the fall of Constantinople, Greek medicine reached modern Europe. He then traced the growth of the universities of Bologna and Montpelier and their influence upon medicine, particularly the former, where anatomy was first studied. Medicine of the middle ages was a restatement from century to century of the facts and theories of the Greeks, modified here and there by Arabian practise. In Bacon's phase there was much iteration, small addition.

In lecture four Professor Osler dealt with the beginnings of modern medicine as illustrated in the lives and works of three men. Paracelsus represented the spirit of revolt against authority and tradition. His positive contribution to medicine was small in comparison with the stimulus which his antagonism to the older writers aroused in his generation. Vesalius was the first to describe and illustrate with system and accuracy the structure of the human body. He may be said to be the creator of human anatomy as we know it. Professor Harvey Cushing, of Harvard,

showed a collection of first editions of the works of Vesalius, among which was the Fabrica of 1543, one of the most sumptuous works ever published. Harvey—the first great student of a function of the body—demonstrated the circulation of the blood in a series of masterly experiments which have been a model for all subsequent workers. In the publication of the "de Motu Codris." modern physiology may be said to have had its origin.

In lecture five Professor Osler described the steps by which we had obtained our knowledge of the changes wrought in the body by disease—morbid anatomy, the rise of clinical medicine, the introduction of means of physical diagnosis and the development of experimental pathology. The modern study of infectious diseases was traced, the work of Pasteur and of Koch described, and the practical application by Lister of the antiseptic method. The new problems in relation to the internal secretions were discussed, and it was held that the future would be largely concerned with studies in metabolism and clinical chemistry.

In the last lecture the practical application of the knowledge derived from recent researches was considered in relation to some of the more important diseases. The story of malaria was told in full and it was urged that a more active campaign against the disease should be undertaken in the southern states. The victory over yellow fever was retold, and the experience of the Panama Canal Commission was held up as a model showing what efficient organization will do. The building of the canal was made possible by the work of Laveran and of Ross and of Walter Reed and his colleagues. An appeal was made for more efficient control of typhoid fever and for a continuance of the fight against tuberculosis.

PROFESSOR BOWMAN'S EXPEDITION TO THE CENTRAL ANDES

Professor Isaiah Bowman, of Yale University, sailed from New York on April 26 to conduct a South American expedition under the auspices of the American Geographical Society. His purpose is to complete the investigations he began in 1907 in northern Chile and Bolivia and continued in 1911 in the basin of the Urubamba River, Peru. His work this summer will be in that part of the central Andes lying in Peru, northwestern Argentina, adjacent portions of northern Chile and southwestern Bolivia. Professor Bowman will be accompanied by Mr. H. S. Palmer as geologist and a surveyor.

His field work will chiefly relate to the anthropogeography and the physiography of this region. The investigation of topography, drainage and climate will thus go hand in hand with the distribution and customs of the people. Part of the work will lie in the driest portions of the Puna of Atacama and the adjacent desert of Atacama where villages in isolated situations, vast salt plains and lofty table lands alternate with rugged volcanic masses and snow-capped sierras. It is a little-known region and some of the most interesting parts of it have not yet been studied scientifically. The climatic conditions are of great interest and the possibility exists of securing critical data on past changes of climate since the region lies in the transition zone of the horse latitudes, between the trades and the westerlies. The shifting routes of trade have had remarkable effects on the towns and villages scattered along them, not only in stimulating them to an unnatural degree, but also in sudden decay.

An attempt will be made to cross the Andean Cordillera and the Desert of Atacama along two different parallels where the contrasts in altitude are most marked and thus to study the distribution of people under extreme conditions of physical environment.

The last part of the field season will be spent in investigating the border of the Titicaca Basin and descending the Desaguadero River as far as possible towards Lake Poopó. The elevation of the ancient strand lines of Lake Minchin, which once occupied a part of the Bolivian high plateau, will be determined. The relations of this now vanished lake and Lake Titicaca have never been investigated and the key to the problem will be sought in the outlet of the Titicaca Basin. There, also,

must be sought the key to much of the early history of the Titicaca depression. The Tiahuanaco Valley and its celebrated ruins will be studied in relation to the supposed ancient levels of Lake Titicaca and the limits of food production in the valley to-day.

Professor Bowman's results will be published in preliminary form in the *Bulletin* of the American Geographical Society and in final form in a volume entitled "The Central Andes."

GLACIAL EXCURSION OF THE CANADIAN GEOLOGICAL CONGRESS

SEVERAL of the excursions, in connection with the twelfth International Geological Congress, held in Canada next summer, will go from Toronto to Vancouver. Then an excursion (C8 August 29 to September 22), under the leadership of R. G. McConnell, and with guidance of R. W. Brock, D. D. Cairnes, and W. W. Leach, will traverse the fiords of British Columbia, ascend the Skeena River valley from Prince Rupert to Aldermere by rail, visiting the silver-lead mines and coal mines, and continuing to Skagway by steamer. There will be stops at the copper mines on Portland Canal and the Treadwell gold mine on the Gastineau fiord at Juneau. The excursions will then cross the Canadian Coast Range by the White Pass and Yukon Railway to Whitehorse, stopping at the copper deposits there and the coal mines at Tantalus, descending the Yukon River to Dawson and the Klondike gold field in the driftless interior plateau near latitude 64° north.

After the return to Skagway an excursion, under the direction of Lawrence Martin of the University of Wisconsin, will be made, on a special steamer, to the Malaspina Glacier, Yakutat Bay, and Muir Glacier, where Russell Wright, Reid, Gilbert and Tarr have done world-renowned work. This glacial excursion will last five days, with a possibility of two days more in case of cloudy weather.

The first day will afford an opportunity of seeing the Fairweather and St. Elias Ranges, 16,000 to 18,000 feet high, and covered by snowfields and glaciers. These ice tongues include the La Perouse, Malaspina and many smaller glaciers. The front of the great piedmont ice sheet of Malaspina Glacier will be followed, affording an opportunity of seeing the tidal ice front of the Guyot lobe west of Yahtse River, the moraine-veneered ice cliff of the Seward lobe at Sitkagi Bluffs, and the forest-covered terminus of the Marvine lobe near Point Manby.

On the second day something will be seen of the eastern border of Malaspina Glacier in Yakutat Bay and the forested terminal moraine of the Yakutat Foreland. Landings will be made in Disenchantment Bay in connection with various glacial phenomena such as the shrub-covered ablation moraine upon the ice of Variegated Glacier, the streams engaged in carrying and depositing outwash gravels, the calving of icebergs from Hubbard and Turner glaciers, the cirque vacated by a fallen glacier, and the beaches, rock benches, sea cliffs and islands which were uplifted from 7 to 47½ feet during the earthquakes of September, 1899.

The third day will be spent on and near the Nunatak Glacier in Russell Fiord. Here the hanging valleys, the till-veneered, overridden outwash gravels, and the tidal, land-ending and cascading glaciers will be visited and studied, as well as the phenomena of glacial erosion in the barren area from which the ice has recently retreated and of fault scarps made during the 1899 earthquake. Some of these scarps are vertical and are 4½ to 8 feet high.

The fourth day will afford an opportunity of seeing the morainic and glacio-fluviatile phenomena about the terminus of the Hidden Glacier, which advanced 2 miles between 1906 and 1909, as a result of the earthquake avalanching in 1899 which has subsequently caused 9 ice tongues of Yakutat Bay to move forward. After this landing something will be seen of a fiord with submerged hanging valleys, submarine moraines, buried forests, shorelines depressed in 1899, and the high strand lines of a former glacial lake.

Part of the fifth day will be devoted to

Glacier Bay, where there has been a recession of 8¾ miles at Muir Glacier from 1899 to 1911. A landing will be made in Muir Inlet to see the buried forests, the vertical ablation of over 1,200 feet of ice in 12 years, and many other phenomena. The rapid recession of Grand Pacific Glacier in Reid Inlet at the head of Glacier Bay now places part of this fiord in Canada. The glacier melted back 5,000–7,400 feet in two months during the summer of 1912, as was determined by N. J. Ogilvie of the Canadian Boundary Survey. At the International Boundary there is now dry land and open fiord where the ice was at least 1,750 feet thick as recently as 1894. Sixty miles of Glacier Bay have been opened to the ocean by glacier recession since 1794, making an arm of the sea as long as Hardanger Fiord in Norway.

The National Geographic Society of Washington has made a grant of money to Professor Martin to enable him to make detailed studies at Grand Pacific and Muir Glaciers while the excursion is in the Klondike. He will (*a*) measure the recession of several ice tongues in Glacier Bay, (*b*) look for advances of glaciers, (*c*) study the exhumed forests in relation to former glacial oscillations, and (*d*) make soundings in Canada's new harbor and other uncharted waters recently vacated by the glaciers, to see the effects of ice sculpture below sea-level.

SCIENTIFIC NOTES AND NEWS

A TABLET in honor of Dr. Samuel Pierpont Langley was unveiled in the Smithsonian Institution on May 6. Addresses were made by Dr. Alexander Graham Bell and Dr. John A. Brashear. At the same time Langley medals were awarded to M. Gustave Eiffel and Mr. Glenn H. Curtiss. Later in the afternoon the Aero Club of Washington arranged hydroaeroplane maneuvers on the grounds of the Army War College in honor of Dr. Langley.

THE Chemical Society, London, will hold a special meeting on May 22, when a lecture in memory of Jacobus Henricus van't Hoff will be delivered by Professor James Walker, F.R.S., of Edinburgh.

DR. JOHN M. CLARKE, New York state geologist and director of the state museum, has been invited by the president and council of the Royal Society of Canada to deliver the annual public address before the society at Ottawa on May 28.

DR. E. F. ROEBER has been elected president of the American Electrochemical Society.

DR. A. E. KENNELLY, of Harvard University, has been elected an honorary corresponding member of the British Association for the Advancement of Science.

PROFESSOR L. J. LANDOUZY, dean of the Paris faculty of medicine, and known by his researches on nervous diseases and tuberculosis, has been elected a member of the Paris Academy of Sciences, in succession to the late M. Teisserenc de Bort.

SECRETARY LANE has announced the selection of Professor Adolph C. Miller, who holds the chair of economics and commerce in the University of California, as first assistant secretary of the interior. Secretary Lane intends to assign to Mr. Miller general supervision of the Bureau of Education and of the national parks; the direction of eleemosynary institutions, such as Howard University and the Government Hospital for the Insane, and the handling of legislative matters in connection with the constructive policies of the department.

DR. KARL KOETSCHAU, director of the Kaiser Friedrich Museum in Berlin, has accepted the directorship of the newly established Central Museum in Dusseldorf.

DR. ALBERT M. REESE, professor of zoology in West Virginia University, sailed on May 5, from San Francisco, on the army transport *Sherman* for Manila, to study the fauna of the Philippines and other regions of the orient, and to make collections for the Smithsonian Institution, from which institution he holds a commission as "collaborator in zoology." He will return to the United States in September.

FORMER PRESIDENT GEORGE E. MACLEAN, of the State University of Iowa, has accepted temporarily the position of specialist in higher

education in the U. S. Bureau of Education. He sailed May 1 for Europe to continue studies of the British universities upon which he will prepare a bulletin somewhat along the lines of his bulletin on "Present Standards of Higher Education in the United States," just issued by the bureau.

THE adjudicators of the Adams Prize of the University of Cambridge report that the two essays submitted to them with the following titles are of distinction: "The Theory of Radiation," by Mr. S. B. McLaren, and "The Fundamental Spectra of Astrophysics," by Dr. J. W. Nicholson, between whom the prize is divided in equal shares.

PROFESSOR C. J. KEYSER, of Columbia University, delivered the annual lecture before the Minnesota chapter of the Society of the Sigma Xi on April 24. The subject of his lecture was "Concerning the Figure and the Dimensions of the Universe of Space."

PROFESSOR WILLIAM MARSHALL, of the department of mathematics, addressed the Purdue Chapter of Sigma Xi on "The Theory of Relativity and the New Mechanics," on April 23.

PROFESSOR BERNHARD KRÖNIG, professor of obstetrics at Freiburg, has accepted an invitation to lecture on Röntgen and radium therapy for the American surgical society, Chicago.

PROFESSOR WILLIAM MORRIS FONTAINE, for thirty-one years professor of natural history and geology in the University of Virginia, distinguished for his researches in paleobotany, died suddenly of heart failure about one o'clock on April 30. Professor Fontaine was in his seventy-eighth year. After eminent service for forty years as teacher and investigator, Professor Fontaine retired in September, 1910, on the Carnegie Foundation.

PROFESSOR A. C. ELLIOTT, professor of engineering at the University College of South Wales and Monmouthshire, has died at the age of fifty-two years.

DR. ERNST GEORG RAVENSTEIN, the distinguished geographer and cartographer, has died at the age of seventy-nine years.

THE U. S. Civil Service Commission announces an examination on June 2, 1913, for associate physicists, qualified in mechanical or civil engineering and in electrical engineering, to fill vacancies in these positions in the Bureau of Standards, at Washington, D. C., at salaries ranging from \$2,000 to \$2,700 a year, the salaries actually paid depending upon the qualifications of those selected.

THE British Board of Agriculture and Fisheries proposes to award in October next twelve research scholarships in agricultural science, of the annual value of £150 and tenable for three years. These scholarships have been established in order to train promising students under suitable supervision, with a view to their contributing to the development of agriculture, either by carrying out independent research or by acting in an advisory capacity to agriculturists. They will be granted only to students who show distinct promise of capacity for advanced study and research in some one of the sciences bearing on agriculture. Applicants must be graduates of a university or holders of a diploma of a university or college of university rank, and application should be made not later than June 9 next on a form to be obtained from the secretary, Board of Agriculture and Fisheries, Whitehall-place, London, S.W.

AN industrial fellowship in plant pathology for the study of diseases of the potato has been established at Rutgers College, New Brunswick, N. J. Candidates for this appointment should write to Professor Mel. T. Cook at the above address.

GOVERNOR SULZER of New York has signed a law creating a State Board of Geographic Names, which is to consist of five members, of which the commissioner of education and the state geologist are *ex officio* members, and three of whom shall be appointed by the governor. The state geologist is the secretary and executive officer of this board. According to the wording of the law, the board is to have power as follows:

First. To determine and establish the correct historical and etymological form of the place names of the state and to recommend the adoption of such forms for public use.

Second. To determine the form and propriety of new place names proposed for general use, and under the law no corporation, individual or community is permitted to introduce such new place names without the consent and approval of this board.

Third. To cooperate with the United States Board of Geographic Names and with the United States Postoffice Department in establishing a proper, correct and historically accurate form for all place names proposed as designations of new postoffices.

UNIVERSITY AND EDUCATIONAL NEWS

Both houses of the Minnesota legislature have passed an appropriation bill granting practically everything asked for by the University of Minnesota. The bill carries items as follows:

Maintenance	$966,000
Fuel	120,000
Special maintenance	462,000
Special agricultural maintenance	326,000
Buildings and equipment	639,950
Agricultural substations	276,500
Special, certificate-plan, bill	500,000
	$3,290,450

Buchtel College, a successful institution of forty years' standing, has been offered to the city of Akron, Ohio, for use as a municipal college or university, according to information received at the United States Bureau of Education. The corporation of the college finds that the institution has trebled its attendance in the past ten years without sufficiently increasing its endowment, and proposes to transfer the entire plant and endowment, valued at $400,000, to the city, practically without restrictions of any kind. If the offer is accepted, Akron will have an educational institution of college grade that will meet the community's needs in a distinctly modern way. It will be known as the College or University of the City of Akron, although in the event of the establishment of other schools or colleges the name Buchtel College is to be retained for the liberal arts department, just as McMicken College is a part of the University of Cincinnati. In making their proposal the trustees point out, among other things, that as a municipal institution, and with very slight addition to the money now spent for educational purposes by Akron, the college would offer to all qualified students of the city a college education with free tuition; that the college can be made of practical use in the work of city government; and that the college will furnish an excellent basis for a greater municipal university that shall make ample provision for technical and professional training for the youth of the city.

To study the methods by which the University of Wisconsin is serving the state in various ways, a party of fifty public officials and prominent citizens of Philadelphia and other cities of Pennsylvania have arranged an inspection trip to Madison, Wis., for four days, from May 21 to May 25. The Pennsylvanians are particularly interested in the relation of the university to the state, cities and rural communities through the medium of the extension division's municipal reference library, commercial reference library, traveling package libraries, correspondence study courses, health bureau, classwork among students in extension centers in all parts of the state, vocational guidance and continuation school work. The distinctive work being done by the College of Agriculture through its own extension service, which includes demonstrational work on how to grow crops, improve the dairying industry, increase farm profits through the introduction of efficiency in farm management, etc., has also aroused the interest of the delegation from Pennsylvania. The ultimate object of the visit is to develop similar activities in connection with the University of Pennsylvania and Pennsylvania State College. The party will include, among others, Mayor Rudolph Blankenburg, of Philadelphia; Owen Wister, the novelist; representatives from the University of Pennsylvania, Pennsylvania State College and Franklin Institute; public officials from various cities; John P. Connelly, chairman of the

finance committee of the city of Philadelphia, and Morris L. Cook, director of the public works of Philadelphia.

THE trustees of Dartmouth College have voted, after the year 1914, to suspend for the present instruction in the last two or clinical years of the Medical School and to concentrate the resources of the school upon the first two years in medicine. Students thus trained will be well qualified to enter the third year of the courses offered by the best city medical schools and may there complete their clinical preparation for the degree of doctor of medicine. The reason given by the trustees for this action is that because of its location the school has found difficulty in meeting satisfactorily the steadily advancing requirements set by the medical profession for a larger supply and variety of clinical material for purposes of instruction. By the action of the trustees also provision is made to extend the work in business organization and management and in commerce. Principles of business management, heretofore a second-year course, will be given the first year. Professor Person and Henry Woods Shelton, appointed assistant professor, will offer new advanced courses in the application of principles of management in manufacturing and merchandizing, including selling, advertising and other specialized branches.

PROFESSOR ERNEST C. MOORE, head of the department of education at Yale University, has received an offer to become professor of education at Harvard University.

DR. JOEL H. HILDEBRAND, of the University of Pennsylvania, has been appointed assistant professor of chemistry in the University of California.

DR. ERNST HEDINGER, professor of pathological anatomy at Basle, has accepted a call to Königsberg in succession to Professor F. Henke.

MR. A. R. HINKS, F.R.S., chief assistant at the Cambridge University Observatory, has been appointed Gresham professor of astronomy, London, in succession to the late Mr. S. A. Saunder.

AT a meeting of the electors to the Plumian professorship of astronomy in the University of Cambridge, held on April 19, Mr. A. S. Eddington, chief assistant at the Royal Observatory, Greenwich, was elected to the professorship, in succession to the late Sir George Darwin.

DISCUSSION AND CORRESPONDENCE

THE NEED FOR ENDOWED AGRICULTURAL RESEARCH[1]

TO THE EDITOR OF SCIENCE: There exists a widespread confusion of thought in regard to what is needed for the advancement of the science of agriculture in distinction from what is needed for the promotion of the practise of scientific farming. Actually these two things are entirely distinct, and what is of great aid, or even essential to one, is usually of relatively little value to the other, and indeed may indirectly become a hindrance to it. To advance the science of agriculture means to make new and fundamental discoveries in regard to the natural laws on which crop production and animal production depend. To promote such advance plainly demands the conducting of scientific research of the highest type in the field of agriculture and the pure sciences—physics, chemistry and biology—which are fundamental to it. On the other hand, to advance or promote the practise of scientific farming means (*a*) to put into the hands of the practical farmer the most complete and authentic information which exists

[1] This communication was called forth by the discussion which has been going on in the newspapers regarding the proposed plan of Mr. Vincent Astor to utilize his estate for the promotion of agricultural science. It was originally published in the New York *Times* for February 21, 1913. The editor of that paper, however, saw fit to omit considerable portions of the communication as submitted to him, including the discussion of what I believe to be the most essential point indicating the need for endowed, as supplementary to tax-supported, agricultural research. The result was what I can only regard as an unfair and inadequate presentation of my views on the subject. Since the matter is unquestionably one of real significance to the cause of American science, I venture to offer here a complete statement of my position.

in regard to the scientifically correct principles and methods of farming, and (*b*) to stimulate him by every possible appeal to reason, ambition and thrift to put these methods into practise on his own farm.

From this brief statement it will be apparent that, broadly viewed, the successful promotion of scientific farming must depend in the long run on the advance made in the science of agriculture. The farmer can not be taught new principles and methods until these have been discovered by the investigator. All federal and state legislation in this country looking towards the development of our agricultural resources has included in its purview these two complementary, but in practise somewhat conflicting needs. But there has been comparatively little effective effort (aside from the Adams Act, which has unquestionably been of great aid to the cause of agricultural research) sharply to distinguish between these needs and to provide definitely and precisely for each. Generally speaking, and with the exception noted, the provisions for tax-supported agricultural work in the United States have attempted to kill two birds with one stone. The result has varied in different localities, but on the whole it may fairly be said that the effect has usually been much more marked on one of the birds than on the other. Undoubtedly this country leads the world today in the effective promotion of scientific farming. This enviable position has been gained through our splendidly organized system of agricultural education, comprising the colleges of agriculture in every state with their intramural instruction, on the one hand, and their extension activities, which reach an astonishingly large proportion of the farming population, on the other hand. Furthermore, to supplement the extramural work of the colleges we have the work of the experiment stations and state departments of agriculture and the federal department of agriculture. These institutions reach the farmer in many ways, but chiefly by the dissemination of useful information in the form of bulletins, and other (even more ephemeral) forms of literature. On the whole, it would be difficult, and indeed no one has ever done so, to devise a better and more effective system for the promotion of scientific farming than that which we now enjoy the benefits of in this country.

But what of the advancement of the science of agriculture? There we meet a totally different condition of affairs. Comparisons are proverbially odious, but I very much doubt if many *disinterested* scientific men acquainted with the field could be found to affirm that in this particular we lead the world. Theoretically it is a primary function of the state experiment stations to conduct researches of a fundamental character which shall be calculated to discover basic natural laws. Actually, with a few rare and partial exceptions, experiment stations do nothing of the sort. On the contrary, what they do engage in is experimental work of a kind carefully calculated to make as strong an appeal as possible on the basis of its supposed "practicality" to the scientifically uneducated and uncritical farmers who make up its constituency. The experiment station investigator in many cases (though happily not in all, as I am able personally to affirm after five years' experience in Maine) is compelled by force of circumstance over which he has no control to supplicate the great goddess Truth with one ear closely applied to the ground in order that he may catch the first and faintest murmur of "what the public wants." If he has the temerity to venture upon a piece of research for which by the most extreme sophistry no evidence of immediate practicality can be adduced, he must do the work *sub rosa* and publish the results in such place that by no possible chance can the constituency ever learn of it.

What has been said can not justly be regarded as a criticism of American experiment stations or their responsible managers. It is simply a fair and candid statement of an existing condition of affairs, which limits the usefulness of experiment stations in certain directions. The reason for the existence of this condition *primarily* lies *not* in any lack of high scientific ideals on the part of the directorate or the workers, nor in any mismanagement, either intellectual or material, of their institutions, *but is found in the fact that they are tax-supported.* The people who

support an institution by the payment of taxes rightly feel that it is their institution. If it engages for a considerable period of time in activities of which they do not approve, or which they regard as useless and frivolous they will either withdraw their support, or if this is practically impossible, they will, by the pressure of public opinion, bring about changes in its management until they get it controlled by men whose policy meets with their approval. Every experiment station worker knows this obvious fact. He must govern his actions in accordance with it if he desires to do *any* useful work in this field. Because of this fact, which is from one point of view a great advantage, the experiment stations have come to take a very important part in the promotion of scientific farming. Their achievements in this direction, viewed as a whole, over the past twenty-five years, are noteworthy in a high degree. But doing this has left but little time, energy, resources or brains available for fundamental research in agricultural science.

The greatest need of organized agricultural development in this country at the present time is, I venture to think, an endowed institution for agricultural research, which shall do for the science of agriculture what the Rockefeller Institute is doing for the science of medicine. This need the state experiment stations never can entirely fill, for the reason that the farmers of the country collectively are not and can not be expected to be qualified to judge either (*a*) what are fundamental problems or fields in which research should be carried on, or (*b*) what lines of investigation are likely to advance knowledge, or (*c*) what are appropriate methods of investigation in general and in particular. Yet these are matters which the interested taxpaying public in actual fact does, and will continue to pass judgment upon in the case of tax-supported institutions. I have no criticism to offer on this attitude of mind. It is human, and understandable, and has led to some excellent results, and I have no quarrel with it whatsoever. I merely affirm that it is not one well calculated to promote the advance of science. He who will endow on a scale in some degree commensurate with the importance of agriculture in the social and economic system, an institute for agricultural research and place its management in the hands of a board of directors, of which a majority shall be scientific men of standing, will do the world a service of inestimable value.

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BLOCKS AND SEGMENTS

IN the issue of SCIENCE for January 31, 1913, Dr. Geo. I. Adams proposes the use of the word *segment* for a general term to be applied to a minor part of the earth having the dimensions of a solid. He finds that this term has already been used in Chamberlin and Salisbury's text-book of geology in discussing continental and oceanic segments and asks, "If it is applicable to major elements, why not to minor ones as well?" The note is not untimely, as it is evident that there are some divergent practices in the selection of terms to denote the categories in question. A quotation is given from a prominent geologist who uses the word *segment* in the way to designate a minor part of the earth's exterior marked off by some structure. It is not evident, however, if the writer of the quotation meant to use it in as wide a sense as proposed in Dr. Adams's note; for it appears that Dr. Adams would apply the name segment to all parts of the earth's exterior marked off by faults.

It seems that a term has long been in use, at least among American geologists, to denote a minor part of the earth's exterior marked off by faults. This term is *block*, a short, clear-cut, Anglo-Saxon word, very suitable for such use as is now proposed for segment. The use of the word segment by Chamberlin and Salisbury is, as it appears to me, for the purpose of denoting parts of the earth, more or less commensurate with the geosphere itself. The term seems very appropriate in that sense. Smaller parts of the earth's exterior, marked off by faults or sharp folds, especially when not discussed in connection

with cosmogenetic problems, ought to be designated by a different term. The need of such a term has long ago prompted its adoption, as will be evident from the following quotations from various text-books and geological papers, selected somewhat at random.

"Manual of Geology," Dana, 4th ed., p. 866:

The ridges of the Great Basin . . . have been assumed to be each limited by faults . . . and to have become, in effect, monoclinal orographic *blocks*.[1]

"Elements of Geology," LeConte, 5th ed., p. 239:

The strata are broken into prismatic *blocks*. . . . The slipping of these *blocks* has given rise to cliffs.

"An Introduction to Geology," Scott, 2d ed., p. 5:

Rocks are divided into still larger masses or *blocks* by . . . fissures and planes of dislocation, or faults.

(Pp. 464 and 465): The plateau of basalt has been fractured into a series of *blocks* which are tilted. . . .

"Exploration of the Colorado River of the West, and Its Tributaries," Powell, p. 184:

The faults . . . divide the district under consideration into long belts or *blocks*. . . . In examining the downthrow of these *blocks*, it is observed. . . .

"Geology of the Henry Mountains," G. K. Gilbert, p. 23:

The strata of the upper part of the arch (of Mt. Ellsworth) are divided (by faults) into a number of prismoid *blocks*.

"The Geology of the Eastern Portion of the Uinta Mountains," by J. W. Powell, pp. 16, 17:

When the *blocks* into which a district of country has been broken by faults are greatly tilted . . . the uplifted edges of such *blocks* often form long mountain ridges. . . . In this region many zones are found to be divided into small *blocks* by faults. . . . Fig. 4 is a bird's-eye view of the *blocks* mentioned. . . . Fig. 5 is a diagram of the same region showing the *blocks* into which it is severed. . . . Many other areas far more complex than these have been discovered where a zone has been broken into *blocks* and these *blocks* tipped and contorted. . . .

[1] Italics here and below by the writer of this note.

"The Ore Deposits of New Mexico," Lindgren, Graton and Gordon, Professional Paper 68, U. S. Geological Survey, p. 25:

The principal disturbances . . . are marked by a series of . . . ranges of apparently tilted *blocks*.

Bulletin of the University of Texas, No. 93; "A Sketch of the Geology of the Chisos Country," p. 80:

It (the Chisos country) covers a part of a sunken *block*, which measures about 39 miles from east to west and which has settled from four to six thousand feet below the level of the terranes on either side.

SCIENCE, N. S., Vol. XXXVII., No. 945, p. 226:

Keyes speaks of the "so-called fault-*block* mountains" and refers to a statement by Spur that no one has ever seen the fault-lines *blocking* out the desert ranges.

It will be seen from these quotations that *block* is a term which has long been in use, and which is being used at the present time with a definite meaning, similar to that proposed. It seems to be needed. If retained and used in the same sense as heretofore, it will aid in giving greater precision to the geological nomenclature. We need the term *segment* for a slightly different use, as already stated.

J. A. UDDEN

UNIVERSITY OF TEXAS

CRITICAL CRITERIA ON BASIN RANGE STRUCTURE

CHARLES R. KEYES in a recent number of SCIENCE[1] presents a note entitled as above in which he expresses in general terms his lack of belief in "Basin Range Structure," so called, and suggests deflative agencies rather than local tectonic displacement as the important factor in the formation of such ranges.

The writer has no desire at this time to defend the hypothesis of basin range structure, though he is thoroughly convinced of the

[1] N. S., Vol. 37, No. 945, p. 226.

soundness of this tenet: but only to right any misconception which may arise from the slightly ambiguous statement made by Mr. Keyes in which the writer's name is mentioned. To be explicit: Mr. Keyes says: "The present sharp meeting of mountain and plain is now explained by causes other than dislocation, through ordinary stream corrosion according to Paige."

The writer wishes to say that in the paper from which the idea above is drawn[8] the process under discussion was the formation of certain sloping planated rock surfaces which though likely to originate on the borders of enclosed desert basins do not in the process of their formation vitiate in any way the hypothesis of basin range structure. In fact, such surfaces may be used to prove (by their elevated positions) the very existence of such faults as are needed to establish the basin range structure. They are but an incident in a long series of changes of which basin range structure itself is but a minor part. After all there is nothing inherently antagonistic in processes of deflation, stream erosion or block faulting. All have operated and are operating to-day and any explanation of physiographic forms or account of physiographic history which would ignore any one of them is open to obvious criticism.

SIDNEY PAIGE

[8] "Rock-cut Surfaces in the Desert Ranges," *Journal of Geology*, Vol. 20, No. 5, 1912.

AN INVESTIGATION OF A "HAUNTED" HOUSE

CALLED by telephone a few days ago to examine a large and handsome house in the Back Bay district of Boston for the reason that it was acquiring an unfortunate and annoying reputation as being "haunted," the writer found a really serious state of affairs.

The trouble centered in the third and fourth stories, which were occupied by the children and servants—the slumbers of whom were disturbed by strange sensations. It was said to be a common occurrence for servants to awake in the night with a sensation of oppression, "as if some one were tapping upon me," or with a "creeping feeling going all over me with a feeling of being paralyzed." Sounds were also said to be heard, as if some one were walking about the house or overhead. These sensations often continued after the sleeper was thoroughly awake and even after the lights had been turned on. The children of the family, who also slept on the upper floors, were similarly affected. A little boy, for example, awoke one night and inquired of his nurse why she had been lying on him, and persisted for some time in his delusion. Another child rushed screaming into the nurse's room crying that a man was waking him up, and asking why she let the man frighten him so. The children appeared sluggish in the morning and pale, even cold water losing its power to enliven them.

These and other symptoms were well defined and often repeated, and had extended over the period of about two months during which the family had occupied the house as tenants. Upon inquiry it appeared that previous tenants had been troubled in the same way, matters having reached the point where the servants actually talked of seeing walking apparitions. The present occupant, although not entertaining any vitalistic theory of the phenomena, was fully alive to the reality and gravity of the situation, and anxious to find the underlying cause.

A comparatively simple and mechanistic solution of the problem soon appeared. It had been suspected that the trouble might have its origin in undetected leaks of illuminating gas, and the writer was called in to verify this theory. It developed, however, that the large amount of "furnace" gas escaping from a viciously defective hot-air furnace was quite sufficient to cause the trouble. In this furnace the separation between the fire box and the hot air ducts (upon which the hygienic integrity of the apparatus depends) was badly broken and as a result the inhabitants of the house were bathed in an atmosphere of diluted flue gases. To make matters worse, a small boiler for a steam-heating system had been placed within the fire box directly over the fire, the effect being to cool the top of the fire and so promote incomplete combustion.

In the light of these facts the sufferers' symptoms are readily explained. Flue gases contain, and especially when combustion is incomplete, considerable amounts of sulphurous oxide and carbon monoxide, both distinctly poisonous gases. Furnace gas was common in this house and often very strong—so that the eyes watered and an appreciable effect could be felt in the throat, symptoms at once suggestive of sulphur. The rapid tarnishing of all silver objects was a further indication of the presence of this substance. For the most serious symptoms, however, the responsibility must be thrown on carbon monoxide. The poisonous nature of this gas is too well known to require comment, and sensations of oppression and other mental disturbance are typical of the more acute poisonings, while anæmia, malnutrition, loss of psychic powers and diminished vigor are characteristic of the chronic condition. That the trouble was most aggravated on cold nights—when windows were closed and ventilation poorest, and at the top of the house, is consistent with the furnace explanation. It seems probable that the belief in walking spirits was nourished by real noises coming from an adjoining house. Any such noises would, of course, be likely to be exaggerated in the minds of persons wakened in the night while suffering from carbon monoxide poisoning.

The hygienic lessons are patent. Here is a clear case of thoroughly serious poisoning which might have had at any time a fatal result, and all due to a defective hot-air furnace. This apparatus, often praised for its ventilating effect and probably with justice when in sound condition and properly operated, may evidently become a distinct menace to health. And may not there be similar cases of a milder order, such as escape detection while still causing slight poisoning? Emphasis is also thrown on to the entire question of the possible dangers from flue gases. Brick sewers have been found to be sometimes permeable to illuminating gas; may not these poisonous flue gases sometimes escape into houses through porous or leaky chimneys? Slight leaks of illuminating gas have often been suggested as a cause of headaches and anæmias of obscure origin; perhaps we should look to leaky furnaces and flue gases for similar effects.

This case should also be of interest to experimental psychologists and investigators of psychic and spiritualistic manifestations, since the reputation which this house was gaining as being haunted apparently arose in large measure from genuine sensations of apparitions and the like, induced by the breathing during sleep of a tainted atmosphere.

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SCIENTIFIC BOOKS

Das Erdöl. Seine Physik, Chemie, Geologie, Technologie, Und sein Wirthschaftsbetrieb. In fünf Banden. Herausgegeben von C. Engler und H. v. Hoefer. Leipsig, verlag von S. Hirzel. 1912.

With the vanishing supply of natural gas, and the diminishing output of the world's stock of light petroleum, this work appears at an opportune moment. The first volume edited by Dr. Engler under the title "Die Chemie und Physik des Erdöls," and just issued, contains 855 pages with full index, and 18 large plates, the latter giving complete analyses and optical activity of petroleum from the principal fields.

The scope of this work and its comprehensive magnitude as indicated by its title and fully substantiated by the first volume, promises the most thorough and complete compilation on petroleum and its products that has ever appeared. It is fortunate that its preparation was undertaken by two such well-known workers in this field. The name of Dr. Engler especially is familiar to every one who is interested in petroleum.

Since the comprehensive report on petroleum by Peckham, to the United States Geological Survey,[1] the great accumulation of lit-

[1] Report on the Production, Technology and Uses of Petroleum and its Products, Government Printing Office, 1885.

erature on petroleum has been partly summarized by Redwood,[2] by Richardson[3] and by Clarke.[4] It was evidently the plan of the authors of "Das Erdöl" to include all that is known concerning petroleum, and one does not proceed far in the perusal of this volume to be convinced that their object will be well attained. It is safe to assert that this work will be found readily accessible for convenient consultation by the investigator, experimenter and refiner, for it will be an indispensable aid to every one interested in this subject.

This volume is devoted to the varieties of bitumen as a generic term for solids and liquids, and to natural gas, their composition, genetics, occurrence, chemical and physical properties, optical characters, heats of combustion, fractional distillation and lubrication. But much the larger space is devoted to the composition of petroleum and its products, with a complete review of the series of hydrocarbons that have been found in petroleum. and the structural relations of the various series on the basis of the most recent classification of the hydrocarbons.

There is a full discussion of all investigations of petroleum from the beginning, and large space is given to the work on American petroleum. The identity of the naphtenes first discovered by Markownikow in Russian petroleum with the same constituents in American petroleum, and with the more recently synthetically prepared cyclo-hydrocarbons, is fully set forth.

It is gratifying to observe that the proof of the absence in any appreciable qualities of ethylene hydrocarbons, especially from American petroleum, is comprehensively presented, for the erroneous statements on this subject in all works on petroleum have been grossly misleading. An interesting résumé is given of the facts and theories relating to the natural formation of petroleum from a chemical point of view. The behavior of petroleum and its products towards reagents, the action of atmospheric agencies, oxygen and ozone, as well as light, are critically considered.

The complete description of crude petroleum from all well-known fields, including its composition and properties, will be serviceable to the prospector and the refiner. Pyrogenic decomposition under various conditions, with what is known to the refiner as cracking, receives careful attention, as does also such subjects as absorption, capillarity, conditions and limits of explosion, and physiological effects. Considerable space is devoted to lubrication and the efficiency of lubricants. The theory of viscosity and the laws and practical operation of frictional testing machines are presented, with comprehensive tables and ordinate diagrams of the relative and absolute viscosity of the hydrocarbons, both paraffine and aromatic.

Reference is made to the lack of efficiency of dry lubricants and attention is called to the great advantage of a combination of an oil lubricant with graphite in such form that it reduces very materially the coefficient of friction by saturating the bearing with graphite, and at the same time forming a coherent film. It is explained that the difficulty of obtaining graphite in a sufficiently fine condition has been overcome by the colloidal graphite recently discovered by Dr. Edw. G. Acheson which is used in the form of oildag, a suspension of colloidal graphite in a suitable oil or in the form of aquadag, a suspension in water. Diagrams and results of frictional tests on the Carpenter machine are presented, from which the following interesting conclusions are translated.

> These experiments confirm also the theory that a proper use of the combined oil-graphite lubricant is in high degree profitable. Besides the reduction of the coefficient of friction which is important from an economical point of view, a material saving in wear of bearing surfaces and of the lubricant required are other essential features in reducing the operating cost. Then, too, the factor of safety in operating is essentially larger and the danger of overloading much less than with lubricants containing no oildag. These

[2] "Petroleum and its Products."

[3] "The Modern Asphalt Pavement," J. Wiley & Sons.

[4] "Data of Geo-chemistry," U. S. Geological Survey, 1908.

factors should be of especial importance in the lubrication of motors, flying-machines, automobiles and similar machines.

The work is presented in regard to paper and printing with the characteristic skill and care of the German publisher, and with the patient thoughtfulness on the part of authors and publisher that we are led to expect in German publications.

CHARLES F. MABERY

Applied Biology. An elementary text-book and laboratory guide. By MAURICE A. BIGELOW, Ph.D., Professor of Biology in Teachers College, Columbia University, and ANNA N. BIGELOW, Teacher of High School Biology. 8vo. Pp. xii + 583. New York, The Macmillan Company. 1911. $1.40 net.

Teacher's Manual of Biology. A handbook to accompany the preceding. By MAURICE A. BIGELOW, Ph.D. 8vo. Pp. viii + 113. New York, The Macmillan Company. 1912.

Readers of SCIENCE have sometimes been entertained by bursts of eloquent disapproval of all courses in general biology. Certain noted botanists especially have been wont to speak of such courses as impossible, decadent, reprehensible; as maladies of a peculiar American epidemic, that has, happily, long since run its course. Their ills have been solemnly charged against presumptuous zoologists who have rushed in where modest botanists fear to tread. Fie on any one who would teach about plants and animals in the same course!

This protest has been loud—perhaps a bit too loud; for certain it is that courses in general biology were never so widespread as at the present time, nor were there ever so many new text-books offered for such courses, not only in America, but in Germany and France as well. Perhaps the reason lies in a permanent educational need, which such courses fulfill. There are those who have tried to test the matter by scientific methods who think so.

Among the many new books offered in this field is an important one by the Bigelows for secondary schools. Its title is "Applied Biology," but, fortunately, the applied part of it is mostly in the title. It would be an important book, if for no other reason, because it represents a great deal of honest effort on the part of competent teachers of extensive and varied experience, to put together into one consistent course what they deem best of all that they have tried. One does not need to be committed wholly to its plan in order to agree that it has been carefully laid out, and based on long experience and good judgment.

It is a conservative book. It begins with a chapter on definitions and another on the distinctive characteristics of living things (22 pages). Then follow chapters on the frog and the bean plant, these two types serving as an introduction to animal and plant biology respectively (122 pages). Then follow the more customary series of plant and animal types, the plants in descending, the animals in ascending series (300 pages), leading to a concluding part devoted to the consideration of the principles of biology as applied to human structure and life (118 pages). In all this there is much careful culling of both subject matter and methods: and a well-balanced indoor course for city schools is the result.

The biology taught is distinctly that of the laboratory—not of the outdoors. While there are here and there hints of the existence of outdoor biological phenomena, there is no plan provided for the study of them.

The technical terms used are few, but adequate. One notes almost with surprise how great is the gain resulting from the omission of most of the rubbish of terminology that encumbers the average high-school text. Of more doubtful value is the relegation of most of the laboratory work to demonstration by the teacher. Though this saves time and yields fewer failures of individual experiments, one may well doubt whether the pupil will learn, by handling pen and paper and recording results, what the handling of the things would teach him.

The illustrations are old—some of them so old that the original sources appear to have been lost. The authors seem to think that "well-known figures from standard biological works are to be preferred to new ones." At least, they are cheaper. One notes with regret the perpetuation of the grossly inaccurate fig-

ure of a mayfly nymph (from Parker & Haswell) on page 399; also the confusion of the lettering in figure 32 on page 79 (from Bessey), and the use of the word ovary with very different meaning in this figure and in one on page 244.

Biological pickles do not seem, as a rule, to excite much enthusiasm on the part of a beginner of high-school age and exception may be taken, therefore, to the suggestion on page 389 that for practise with insects "a mixed lot preserved in wood alcohol or formalin is best." But, as a rule, the suggestions as to laboratory methods are excellent and the book, as a whole, is a valuable contribution to the literature of biological laboratory methods.

James G. Needham

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THE SO-CALLED AEROSTATIC HAIRS OF CERTAIN LEPIDOPTEROUS LARVÆ

In his valuable report on the dispersion of the gipsy moth,[1] Mr. A. F. Burgess emphasizes the very great rôle which is played by the wind in distributing the first-stage caterpillars. In this connection he calls attention to, and figures the so-called aerostatic hairs arising from tubercles in first-stage larvæ of the gipsy moth, though he does not commit himself to the theory that they, with their globular swelling at the base, actually aid in making the caterpillars more buoyant.

These peculiar hairs, to be found on first-stage larvæ of the nun moth, as well as of the gipsy moth, were first described by Wachtl and Kornauth[2] under the name of aerostatic setæ, while they designated the balloon-shaped swellings as aerophores. They have been subsequently noted by several workers.

As indicated by the name, the aerophore was supposed to be filled with air, and Wachtl and Kornauth believed that the aerostatic bristles presented a collection of balloons which function as an aeronautic apparatus. If their interpretation be correct, it is obvious that in both the nun moth larvæ and in the gipsy moth larvæ these structures play a very important rôle in aiding the dispersal of the species by the wind.

Those who hold to the view that the swellings are in reality aerophores have not sought to explain how it is that the almost microscopic structures should serve as "balloons" if they are filled with air. A balloon rises because it is filled with gas lighter than air. To be sure, Fernald[3] suggests that they are distended with air "or gas," but it is difficult to conceive of a possible source of a special gas.

Apparently, Professor Cholodkovsky was the first to suggest the true nature of the so-called aerostatic hairs. First, in a Russian forestry journal and then in Tubeuf's *Zeitschrift*[4] he called attention to certain serious objections to Wachtl and Kornauth's hypothesis. The fact that the swellings, or vesicles, shrink in dead larvæ, militates against the view that they are filled with air. On the contrary, it favors the view that they contain a fluid which, after the death of the larvæ, naturally must dry up. In larvæ preserved in alcohol, air-filled organs would soon lose their air content, but these vesicles remain for months as full and rounded as in the living larvæ. If such a preparation is allowed to dry on the slide all of the "aerophores" quickly shrivel.

Cholodkovsky, therefore, suggested that the swellings were not filled with air, but with a fluid, and that very probably this was a poisonous one, since the larvæ, in this stage especially, need protection against insectivorous birds. This view was confirmed by the study of sections, which showed a large, unicellular gland underlying each of the "aerostatic bristles" and opening directly into the cavity.

[1] Bull. 119, Bu. Ent., U. S. Dept. Agric., February, 1913.

[2] Wachtl, F. A., und Kornauth, K., "Beiträge zur Kenntniss der Morphologie, Biologie und Pathologie der Nonne (*Psilura monacha*)," Mittheilungen aus dem forstlichen Versuchswesen Osterreichs, XVI., pp. 1–38, 1893, 3 pls.

[3] Rept. on the Gypsy Moth, Mass. Board of Agr., 1896, pp. 300–301.

[4] Cholodkovsky, N., "Ueber die sogenannten Aërophore der Nonnenraupe," *Forstlich-naturwissenschaftliche Zeitschr.*, III., pp. 240–243, 1894.

Subsequently Ingenitzky,[2] a student of Professor Cholodkovsky's, made a much more detailed study of these glands and distinguished them clearly from the trichogens, the enlarged hypodermal cells which give rise to the hairs.

It seems, then, very clearly established that the so-called aerophores have no function of rendering the larvæ more buoyant, but are really *toxophores*, as Cholodkovsky proposed to call them. The rôle of rendering the larvæ more buoyant may much better be ascribed to the long, thin hairs which, as the Russian observer points out, have an unmistakable resemblance to the pappus of some plant seeds.

WM. A. RILEY

SPECIAL ARTICLES

IS THE BIENNIAL HABIT OF ŒNOTHERA RACES CONSTANT IN THEIR NATIVE LOCALITIES?

THE recent article[1] on "*Œnothera* and Climate," by R. R. Gates, is of particular interest to me since, for the past few years I have had in culture several of the races of *Œnothera "biennis"* from the vicinity of Ithaca, N. Y. Two (possibly three) of these races which are predominantly biennial in character have in culture in their native locality produced annual individuals. In one case (No. 2, *Œnothera nutans*) the seed was planted during March, 1911, and in May the boxes were kept in the garden with one transplanting until June, when they were transplanted in the open garden. From the experiences of the season of 1912, these rosettes of 1911 started in the greenhouse in March were not so far advanced as they would have been had the seed been planted in the open garden in April. Three out of about 50 or 60 came into flower early in September. Rosettes of the intermediate stage were well formed in August but these three individuals did not form the dense rosettes so characteristic of the others in late autumn. Two of these September flowering individuals were potted and taken into the greenhouse, where they flowered all winter. In the spring they were removed to the garden and kept in their pots, where they continued to flower until some time in August, thus flowering continuously for eleven months. Another race (No. 1, *Œnothera pycnocarpa*) under the same conditions remained strictly biennial.

In a third race (No. 17) seed was planted directly in the garden in the early spring of 1912. Eight or ten out of about 200, without the formation of rosettes, came into flower in August, matured seed and died. They were strictly annual. The others are now in the rosette stage.

In another race (No. 16), possibly identical with No. 2, the seed was planted directly in the garden on the same day as No. 17. Out of about 300 individuals one did not form a rosette. It came into flower in August, formed seed and died late in September. This individual was annual, but it remains to be seen if it is a mutant from this race, which can not be determined before the rosettes of the other individuals now passing the winter have come into flower.

From my experience in the culture of *Œnotheras*, which is not extensive it is true, I have come to the conclusion that their behavior as to a strict biennial habit even in their native locality may be different under culture either in the garden or greenhouse from what it is in the open under feral conditions. Fully formed rosettes potted in the autumn and taken into the greenhouse, kept there during the winter and removed to the garden in the spring did not form stems nor come into flower any earlier than those which wintered in the garden.

Another feature of considerable interest which has appeared in connection with some of my cultures may be mentioned here, but an account of the more important results are reserved until after another season's experiences. The feature to which I refer is the possibility of certain races of *Œnothera* becoming perennial or of taking on a perennial habit under certain conditions. Several plants of *Œnothera nutans* which matured in

[2] Ingenitzky, I., "Zur Kenntniss der Drüsenhaare der Nonnenraupe (*Ocneria monacha*)," *Horæ Soc. Ent. Rossicæ*, XXX., pp. 129–134, pl. VIII., Figs. 9–11, 1896.

[1] SCIENCE, N. S., 37: 155, 156, 1912.

late August and early September, were observed during late September and early October, after prolonged rains, to be putting out new branches which came into flower. Some of the stems of those which were dead formed distinct and strong rosettes from the root stock as lateral branches. If these survive the winter the rosettes will probably form stems and the plants will come into flower a second season, that is, the third season from the rosette stage. It would then be a perennial with the habit of a perennial root stock and annual flowering shoot. Several of the individuals which were putting out new branches in late September and early October were potted in early November and removed to the greenhouse where they have continued to produce new shoots, often slender and crowded, sometimes suggesting "witches' brooms." These branches arise from the old brown stalk which to all external appearance one would consider dead but on cutting the stem chlorophyllaceous tissue is seen. The very dark sky during December and January has been unfavorable for growth or flowering, and perhaps accounts to some extent for the spindling growth and lack of flowers during this period. On some of these plants the new growth occasionally wilts down, indicating perhaps that the old stems are somewhat deficient in conduction. After reading Mr. Gates's article (Jan. 24, 1913) I stepped into the greenhouse to see my perennial *Œnotheras* and lo, there was one flower.

This plant (of *Œnothera nutans*) continued to flower in the greenhouse until the middle of April when it was transplanted into the garden. The cold weather following proved to be too great a change from the warm air of the greenhouse and the stems died to the ground, but a small rosette which had formed from the root stock remains alive to this day (May 2). Three of those individuals which formed rosettes during the autumn and were kept over in the garden or in a cold frame have been transplanted to the garden. They are doing well and will probably produce stems and flowers this summer. These individuals, therefore, of *Œnothera nutans* have taken on a perennial habit.

These two species, No. 2, *Œnothera nutans* Atkinson and Bartlett, and No. 1, *Œnothera pycnocarpa* Atkinson and Bartlett are described in the May number of *Rhodora*, 1913.

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THE LOWER CALIFORNIA PRONGHORN ANTELOPE

THE Pronghorn of Lower California has recently been separated by Mr. E. W. Nelson as a sub-specific race. (*Proc. Biol. Soc. of Wash.*, Vol. 25, page 107.) The characters given have to do mostly with color and color pattern, while the horns are mentioned as shorter, rougher, more upright and less diverging than in either of the other forms, *americana* and *mexicana*. No mention is made of skull characters.

A fine series of six adult males and several females were recently sent to me from Calmali, L. C., the type locality of the new form. One of these males is now in the collection of the Biological Survey at Washington; the others are in the Museum of Comparative Zoology.

I have not compared the skins of these specimens, but careful measurements of the six skulls do show a real divergence when compared with five large male specimens from the Laramie Plains, southeastern Wyoming, in the Museum of Comparative Zoology. They are on an average longer in the face, and considerably narrower. The most significant measurements are: length of nasals, length of anterior nares, and smallest width between orbits. The nasal length of the California animals runs from 101 to 110 mm., while the Wyoming specimens show from 84 to 97 mm. Likewise the width between orbits scarcely overlaps in the two series. An arbitrary index of nasal length plus length of anterior nares, divided by width between orbits, gives for the *peninsularis* series 1.73, and for the *americana* series 1.51.

The occipito-nasal length is very much more uniform in the series of *peninsularis* than in that of *americana*, and is somewhat greater.

One specimen from Calmali, original No. 65, shows such an abundant horn development that it ranks fifth largest as to length of horn in Rowland Ward's list (sixth edition). The horns, sixteen and one eighth inches long, show a remarkably divergent tendency, there being seventeen and one half inches between them at the fork. The base measurement is six and one quarter inches, and the general form is clean and symmetrical, not stumpy, knobbed and aberrant-looking like some of the others from the same locality. There seems to be, however, in all the California horns a tendency to a very sharp angular bend at the terminal portion, instead of a gentle or even curve. Therefore this new race of Prong-horn has a characteristic skull modification and can at times produce fine typical horns, in spite of its seemingly unfavorable environment.

The type locality of *A. americana* is an indefinite one and is referred to the Plains of the Missouri. The five *americana* skulls used for comparison were taken near Percy, Wyoming, and are Nos. 43, 46, 49, 50, 52 in the Museum of Comparative Zoology.

J. C. PHILLIPS

WENHAM, MASS.

THE AMERICAN PHILOSOPHICAL SOCIETY

THE annual general meeting of the American Philosophical Society was held in the rooms of the society in Philadelphia, April 17 to 19, inclusive, and constituted a most notable series of sessions. There were a large number of papers presented, their general character being of a high order of merit and the scope of subjects included wide.

The meeting was opened on Thursday afternoon, President W. W. Keen, LL.D., in the chair, when the following papers were read:

The Biographies of Suetonius: JOHN C. ROLFE, Ph.D.

The Etymology of the Word "Ill": HERMANN COLLITZ, Ph.D.

While most etymologists agree in regarding the word "ill" as a loan word from Scandinavian, no plausible etymology has as yet been given of the old Norse word ("illr") from which it is derived. The traditional etymology of the latter word, identifying it with English "evil," is untenable, for phonetic reasons. Both the form and the meaning of this word, however, may be accounted for by regarding it as the Scandinavian equivalent of the English word "idle."

The Treaty Obligations of the United States relating to the Panama Canal: CHARLEMAGNE TOWER, A.B., LL.D.

Former Ambassador Tower discussed the basis upon which the Hay-Pauncefote treaty was concluded with Great Britain, and pointed out the legal obligation of the United States arising therefrom. He went back to the earliest discoverers and navigators and brought up to the present time the history of the governments of Central America, to show our connection with the enterprise of constructing the canal.

He quoted the Clayton-Bulwer treaty, signed in Washington in 1850, by which the governments of the United States and Great Britain declared that neither would ever obtain or maintain any exclusive control over the ship canal, would fortify or colonize, or exercise any dominion over Nicaragua, Costa Rica, the "Mosquito Coast" or any part of Central America.

Also, that neither Great Britain nor the United States would take advantage of any intimacy or alliance that it might have with any government through whose territory the canal should pass, to acquire or hold any rights or advantages in regard to commerce or navigation which should not be offered on the same terms to the citizens or subjects of the other.

By the Hay-Pauncefote treaty of 1901, Mr. Tower said that, being desirous to facilitate the construction of a ship canal to connect the Atlantic and Pacific Oceans, by whatever route might be considered expedient, and to remove any objection which might arise out of the Clayton-Bulwer treaty to the construction of such canal under the direction of the United States, without impairing the general principle of neutralization, the two nations agreed that the Hay-Pauncefote treaty should supersede the former treaty.

It was agreed also that the canal should be built by the United States, which should enjoy the exclusive right to provide for the regulation and management of it. To make the understanding between the two nations plain, the following specific stipulation was entered into:

"The United States adopts as the basis of the neutralization of such ship canal, the rules substantially as embodied in the Convention of Constantinople, for the free navigation of the Suez Canal, and further, 'The Canal shall be free and

open to the vessels of commerce and of war of all nations observing these rules, on terms of entire equality, so that there shall be no discrimination against any such nation or its citizens or its subjects, in respect to the condition or charges for *traffic or otherwise.*' ''

In view of all this the speaker urged that the United States is in honor bound never to do or allow anything which can be interpreted as in any way inconsistent with the terms of our treaties.

A Counsel of Perfection. A Plan for a State University and for an Automatic Collection and Distribution of a State Tax for Higher Education: JOSEPH G. ROSENGARTEN, A.M., LL.D.

In view of the proposed convention to revise the constitution of Pennsylvania, it may not be inappropriate to urge the preparation, consideration and discussion of a provision in the constitution for a mill tax for higher education in Pennsylvania.

The *founder of* the Philosophical Society was also the founder of what is now the University of Pennsylvania.

From the suggestion of a building big enough for George Whitfield's great audiences, Franklin drew the inspiration in 1740 for the Academy of Philadelphia, which grew into the College of Philadelphia, the University of the State of Pennsylvania, and the University of Pennsylvania of our own day.

Franklin (to-day Franklin and Marshall) College, of Lancaster, Pa., was a tribute paid to him in the closing years of his long useful life by his admiring contemporaries.

The constitution of Pennsylvania, adopted in his lifetime, pledged the support of the state to the university.

To-day there are, as reported by the National Bureau of Education, 87 state universities, and other state-aided institutions of higher education. More than twenty-five of them receive the proceeds of the so-called mill tax rate, varying in amount and methods of collection and distribution. Notable among them is the University of Wisconsin, with a tax of three eighths of a mill, yielding $1,103,029, with a total income from the state of $1,552,398, and from the United States of $80,000, under the Morrill land grants, and returning to the state a large and varied service in public work and commissions of many useful kinds.

Under the same fostering care, other state universities have grown rapidly into importance—notably Michigan, Indiana, Colorado, Illinois, Iowa, Kansas, Nebraska, Texas, and state aid thus secured by the mill tax has been supplemented by many magnificent gifts from individuals.

The question of how best to make constitutional provision for higher education has been discussed, and its advantages affirmed by Andrew White, of Cornell; President Swain, of Swarthmore; President Beardshear, of Iowa; President Jesse, of Missouri; Professor Herbert B. Adams and Professor Maphis, of the University of Virginia; Professor Lefevre, of the University of Texas; President Ellis, of Ohio, and by the representative educational leaders from all parts of the country.

In Pennsylvania, with a state revenue of over thirty millions, a mill tax would produce an income large enough to support all the universities and colleges and institutions of higher education in a way to make them of infinite benefit and credit to the state.

With a provision in the constitution for such a mill tax for higher education should go power in the legislature to create a state board of education, including in it the governor and principal officers of the state *ex officio* and representatives of universities and colleges and technical schools and museums.

Let the state be divided into three sections, eastern, middle and western, each with its local educational council, consisting of representatives from all the institutions of higher education in the section, these in turn to send one or more representatives to the state board of education. That body could frame a plan on which the proceeds of the mill tax should be distributed, according to numbers, standards, efficiency and other conditions prescribed for a share of the income from the mill tax.

In due time the weak colleges would see the advantages of union with others, thus increasing efficiency.

The University of Pennsylvania would naturally be the head of higher education in and for the state, other universities and colleges being affiliated with it.

State College should be made the great agricultural school for the state, attracting to it all branches affiliated in that important work, veterinary schools, forestry, conservation of natural resources, etc.

The University of Pittsburgh would be the head of higher education in the western part of the state, and naturally would become the center of all work for educating men in mining, metallurgy, electricity and the other arts and sciences needed in developing the great resources of the state.

Technical schools, the Franklin Institute, the Drexel Institute and similar bodies, as well as such institutions as the Academy of Natural Sciences, the Academy of Fine Arts, the Carnegie Institute of Pittsburgh, should be affiliated.

All degrees in course should be granted by the board of education through the University of the State of Pennsylvania, and to it should be affiliated all examining boards, such as those that now admit to the practise of law, of medicine, of pharmacy and of other professions requiring a state license.

In this way the state would unify and advance the work of higher education.

From the state board of education should come appointments for all scientific and technical commissions, thus enlisting for the state and its needs the service of trained experts in law and legislation, in medicine and the prevention of disease, in mining and other branches of scientific and technical subjects of inquiry.

Such commissions would go far to make a substantial return to the state for the income from a mill tax.

The preparation of a code of laws for the distribution of such an income could follow a provision in the proposed new constitution for the automatic collection of such a state mill tax for higher education.

A similar constitutional provision might be made for a tax for the support of purely public charities, under such regulations as would secure to the state and its people the highest efficiency and the most economical management of hospitals, homes, asylums for the insane, the blind and defectives and dependents.

The state board of charities should be given large powers of inspection and require standards of excellence that would put all such institutions in the highest state of efficiency.

Uniform methods of accounting, supervision of purchases of supplies, constant interchange of officers in charge would secure reforms that of themselves would invite increased gifts from individuals.

With a state mill tax for higher education and for purely public charities, Pennsylvania would take its place with the great western states, in which, with this fostering care, universities have rapidly grown great, in useful work and good results as well as numbers.

Reprisals, Contraband and Piracy under Queen Elizabeth: Edward P. Cheyney, A.M., LL.D.

The English had the reputation in the sixteenth century of being the greatest pirates in Europe. Everywhere that English ambassadors went they were forced to hear complaints of the seizures at sea by their fellow countrymen. The Venetian governor of the Island of Zante reports to his home government, "I am firmly convinced that there is not a sailor of that nation that is not a *pirate.*" *The reasons for this bad reputation* were fourfold. In the first place many letters of reprisal were given by the government. Admiralty courts in many countries were inefficient or not inclined to do justice, and English merchants, after failing to obtain justice for injuries suffered, appealed to their own government and were given letters of mark and reprisal authorizing them to reimburse themselves from the property of fellow countrymen of those who had injured them, even though the governments of the two countries were in close alliance. These letters of reprisal were objects of value and were sold, divided, bequeathed or seized for debt; whoever possessed one having a right to seize goods from foreigners up to the value expressed in it. Seizures made on the authority of such letters seemed legal enough to the possessors, but they were scarcely distinguishable from piracy in the eyes of those whose goods were seized. After 1585, when Spain seized the English ships that were then in her harbors, the English government gave these letters still more freely to any one who could bring forward any shadow of proof that he had lost goods in Spain. This practically amounted to privateering against that country.

Secondly, Spain was largely dependent for food and warlike supplies on France, Holland and the countries along the Baltic. When England and Spain went to war England declared all such supplies contraband and seized ships of those nations taking such goods to Spain. The law of contraband was not yet well developed and the merchants whose goods were seized naturally resented it and declared the actions of the English captains piracy.

Adventurers with letters of reprisal, privateers and captains in the Queen's service seizing contraband, all had commissions for what they did. But there were many genuine English pirates who had no commissions. Their names became famous, they were very bold, were often in collusion with fitting-out merchants on shore or with petty officials of the coast districts, and were comparatively seldom captured or punished. They attacked English and foreign vessels alike and threw overboard passengers and sailors and carried away ships and

goods. In 1573, when the Earl of Worcester was on his way to France to represent the Queen at the christening of the French King's daughter, some pirates swooped down on his ship and carried away all valuables, including the christening presents for the little princess.

The punishment of pirates was very difficult. The usual criminal courts would not act beyond the confines of their own countries and pirates' crimes were usually committed on the high seas. Therefore special courts had to be constructed for their trial. Nine hundred and sixty men were indicted in the special admiralty courts for piracy between 1568 and 1600. When convicted, pirates were usually executed on Wapping on the Thames, a mile or two below London. Twenty-eight were hung there in the year 1575 and fourteen in 1579. A narrative still remains of a pirate named Walton, being led from Southwark to Wapping to be hung, tearing strips from his breeches of crimson taffeta and handing them as keepsakes to his friends who followed him. The government also made strenuous efforts to put down piracy by the appointment of special commissions to hunt out pirates and their confederates and by sending fleets to sea to capture them.

There was, therefore, no lack of actual piracy, but probably not more on the part of the Englishmen than of men of other nationalities. The reason for the especial reputation of the English in this regard was that in addition to piracy of the usual kind they were held responsible for the seizures by letters of reprisal and by privateers and for carrying out the practise of capture of contraband goods, to which England was naturally led by the economic dependence of Spain and her own advantageous geographical location.

Some Commercial Transactions in Babylonia during the Period of Greek Supremacy: ALBERT T. CLAY, A.M., Ph.D.

The Historical Value of the Patriarchal Narratives: GEORGE A. BARTON, A.M., Ph.D.

The science of history has revolutionized our knowledge with reference to the early history of all peoples, showing that the traditions of nations usually begin with mythical stories, which give place gradually to legends, and later emerge into history that is attested by approximately contemporary documents. Inevitably in the progress of knowledge scientific methods have been applied to sacred history. To-day scholars are divided, so far as the patriarchal narratives are concerned, into three groups. (1) The sincere, open-minded, reverent scholars, who believe that the scientific methods must be applied to the beginnings of the history of Israel as to those of other nations. (2) The reactionaries, who resent the application of scientific methods to ancient history. (3) The mythological, or pseudo-scientific school, which has become enamored of the scientific method from afar, but has never undergone real historical training. This school would regard most of the Biblical characters as mythical.

The tenth chapter of Genesis personifies Egypt, Elam, Assyria and many other nations as men. We know that these nations were not descended from one man. Whenever, then, we find a patriarch and a nation or tribe bearing the same name, it is scientific to assume that the patriarch is a personification of the nation or tribe. Arabian tribal traditions afford similar analogies. The twelve sons of Jacob are, then, the personification of the twelve tribes, and their history is tribal history. This was shown to apply to all but Joseph. There never was a tribe Joseph, but two tribes, Ephraim and Manasseh. The marriages of Jacob represent tribal alliances. Neither Joseph, Jacob nor Abraham can be accounted for in that way, as there were no tribes bearing these names. Are these three patriarchs, accordingly, nothing but myths? Is Abraham a moon-god as the pseudo-scientific school holds? Jacob-el, Joseph-el and Abraham were shown from Babylonian inscriptions to have been personal names in Babylonia before 2000 B.C., Jacob-el being sometimes even there shortened to Jacob. Records of Egyptian conquests of Palestine show that there were cities in Palestine named for a Jacob-el, a Joseph-el and an Abram. Many sources point to migrations from Babylonia to Palestine. Probably such men, heading migrations of Amorites, settled in Palestine and cities were named after them, just as we have our Jonesvilles, Billings, etc., in this country. When later Hebrews settled in these cities they gradually took over the names of the men from whom the cities were named, and wove them into their traditions. Around these names traditions gathered from many quarters were crystallized. These traditions can often be shown to embody real history, though history of a different sort from that supposed by the unscientific student of the Bible. Historical study thus makes it more probable that real men stand behind the stories of Joseph, Jacob and Abraham and that they are mythological personages. Many documents were quoted to substantiate the positions taken. One of the most interesting is a contract in which Abraham took part. It reads:

"1 ox, broken to the yoke,
an ox of Ibni-Sin son of Sin-imgurâni,
from Ibni-Sin
through the agency of Kishti-Nabium,
son of Eteru,
Abarama (i. e., Abraham) son of Awel-Ishtar
has hired for 1 month.
For 1 month
1 shekel of silver
he will pay.
Of it ½ shekel of silver
from the hand of Abarama
Kishti-Nabium has received."

The Succession of Human Types in the Glacial and Interglacial Epochs of the European Pleistocene: HENRY FAIRFIELD OSBORN, D.Sc., LL.D.

The Flora of Bermuda (illustrated): STEWARDSON BROWN. Introduced by Professor Henry Kraemer.

In the studies of the land flora of Bermuda which have been carried on since September, 1905, in cooperation with the New York Botanical Garden, the islands have been visited during parts at least of all the months of the year except January, July and October. More than 1,450 separate collections of plants have been made from all parts of the archipelago with the exception of a few of the smaller islands which are only rocks with but little vegetation. The native species of flowering plants and ferns exclusive of the endemic forms number 155, all of which are identical with those existing on the American mainland or the west Indian islands. The fourteen endemic species, four of which have been added through these studies, are all more or less nearly related to those of the southeastern United States, West Indies or tropical continental America and probably derived from such ancestors by modification during long periods of isolation. It would appear, therefore, that the greater portion of the native flora has come to Bermuda from the southwest through the agency of ocean currents, hurricane winds and migratory birds, of which a considerable number of species visit the islands regularly each year.

A New Type of Sewage Disposal Tank: WILLIAM PITT MASON, M.D., LL.D.

Determination of Uranium and Vanadium in Carnotite Ores of Colorado: ANDREW A. BLAIR.

FRIDAY, APRIL 18—MORNING SESSION
William W. Keen, M.D., LL.D., president, in the chair

The Uses and Needs of Selachology (The Study of Sharks and Rays): BURT G. WILDER, M.D.

Interpretations of Brain Weight (illustrated): HENRY H. DONALDSON, Ph.D., D.Sc.

The Correlation of Structural Development and Function in the Growth of the Vertebrate Nervous System (illustrated): GEORGE E. COGHILL, Ph.D. Introduced by Dr. H. H. Donaldson.

Recent studies in comparative neurology have resolved the central nervous system of vertebrates into four longitudinal divisions which are severally functional units. Among lower vertebrates the relative development of these divisions, the somatic sensory, the visceral sensory, the somatic motor and the visceral motor, has been in a significant manner correlated with the behavior of the species. Such correlations by the comparative method formed the point of departure for this study on the correlation of the behavior of embryos with the developing structures in the growth of the nervous system.

Embryos of Amphibia are found to be somatic sensory and somatic motor organisms. They give no evidence of visceral nervous functions until after the locomotor mechanism has become established. This mechanism develops out of three types of nerve cells, sensory, associative and motor. The sensory system of the trunk is formed of the giant ganglion cells of the spinal cord, which connect with the skin by means of dendritic processes. This sensory system of the trunk becomes functional earlier than does the sensory system of the head, which is the definitive system of cranial nerves. The associative cells form a ventral commissure between the sensory cells of one side and the motor cells of the other. The motor cells hold a relatively ventral position in the spinal cord and lower portion of the brain. They form a continuous motor column and tract on either side and connect with the muscles by means of collaterals from their axones. The development of this system of reflex arcs with a single final common path on either side may be distinctly correlated with the development of the behavior of the embryo up till the time when locomotion becomes perfectly established.

Some of the more general results of this method of study are: (1) the demonstration of the nature of the primary reflex arc of the vertebrate nervous system, (2) the discovery of the adaptive nature of the early reflexes when considered from the phylogenetic point of view, (3) proof that the final common path of the most primitive reflexes is elaborated into the nervous mechanism of locomotion, (4) the explanation of the typical be-

havior of a vertebrate upon the basis of demonstrable reflex arcs, (5) a distinctive contribution towards a biological neurology.

The Correlation of Structure and Function in the Development of the Nervous System (illustrated): STEWART PATON, M.D. Introduced by Dr. A. C. Abbott.

The Relation between the Physical State of the Brain Cells and Brain Function (experimental and clinical): GEORGE W. CRILE, M.D., Ph.D.

Life of Cells Outside the Organism (illustrated): ROSS G. HARRISON, M.D., Ph.D. Introduced by Dr. A. C. Abbott.

Heredity and Selection: WILLIAM E. CASTLE, Ph.D.

The Nature of Sex and the Method of its Determination (illustrated): CLARENCE E. MCCLUNG, A.M., Ph.D. Introduced by Dr. George A. Piersol.

Fever: Its Nature and Significance: VICTOR C. VAUGHAN, M.D., LL.D.

It has been shown experimentally that fever is due to the digestion of proteins in the blood and in the tissues. Bacteria are living proteins. They get into the body and grow, converting the proteins of man's body into bacterial proteins. After a period of incubation the cells of the body pour out a ferment which digests and destroys the bacteria. In this process fever originates. In itself fever is beneficial. It is a manifestation of the attempt on the part of nature to destroy the invading organism. However, nature may overdo the matter, and fever per se becomes dangerous when it goes much above 105°. Any kind of fever, acute fatal, intermittent, remittent or continued, may be induced in animals by repeated injections of properly graduated doses of foreign protein.

The Control of Typhoid Fever by Vaccination: MAZYCK P. RAVENEL, M.D.

Vaccination against typhoid fever as practised to-day we owe to the researches of Dr. (now Sir) Almroth E. Wright.

It was tried for the first time on a large scale during the Boer war. Since that time it has undergone investigation by scientific boards in several countries. In the United States it was recommended by such a board in 1909. The results were so favorable that it was made compulsory for all officers and enlisted men under forty-five years of age in 1911.

The most striking results were obtained during the mobilization of troops in Texas in 1911. There were 12,801 troops in Texas, all vaccinated. There was only one case of typhoid fever, occurring in a private of the hospital corps, who had not completed his immunization. The case was mild, and resulted in recovery. In 1898, 10,759 troops were stationed in Jacksonville, Florida, under very much the same conditions as regards climate, etc. Vaccination was not practised at that time. There were 2,693 cases known or believed to be typhoid fever, with 248 deaths. Wherever practised, very much the same story is told. The French troops in Morocco under most unhygienic surroundings have entirely escaped typhoid fever where vaccination was practised.

The method is an extension of the well-known bacterial vaccination discovered by Pasteur. It is now generally recommended for nurses in hospitals and those exposed to the disease.

In Wisconsin the State Laboratory of Hygiene sends out the vaccine free of charge to all physicians in the state. In more than three thousand vaccinations only two cases of typhoid fever have come to our notice; both of these cases mild and atypical.

The method has shown itself of great value in checking epidemics, and in the cure of typhoid carriers.

FRIDAY, APRIL 18—AFTERNOON SESSION

William B. Scott, Ph.D., LL.D., vice-president, in the chair

Guatemala and the Highest Native American Civilization: ELLSWORTH HUNTINGTON, M.A., Ph.D. Introduced by Mr. Henry G. Bryant.

Among the native civilizations of the western hemisphere that of the Mayas was decidedly the highest. Not only did they develop the arts of architecture and sculpture to a surprisingly high point, considering the fact that they had no tools of iron, but they were the only American race to evolve the art of genuine hieroglyphic writing. To-day the magnificent ruins of the later, decadent Maya period, dating about A.D. 1000, are relatively accessible, as they lie in the comparatively dry, open and well-populated strip which borders the peninsula of Yucatan on the north. The oldest ruins, however, those representing the period of highest development a few centuries after the time of Christ, are located in one of the most inaccessible, least explored, most unhealthful and most sparsely populated regions of America. The Guatemalan province of Peten, together with the immediately surrounding regions, where the greatest ruins are located, consists of a plain or low hills lying between the Atlantic Ocean on the east,

the Gulf of Mexico on the north and the high volcanic plateau of Guatemala on the west and south. It is to-day one of the worst possible environments for man. In the first place, it receives so much rain that it is covered for the most part with a dense tropical forest or jungle where the excessive moisture and rank growth of vegetation render it practically impossible to make clearings and practise anything but the most haphazard agriculture. In the second place the region suffers to a maximum degree from the disadvantages of a uniformly warm, moist, debilitating climate. And finally it is afflicted with the worst kind of tropical fevers which weaken and destroy white men and natives alike and render thousands of square miles practically uninhabited.

To-day Peten stands at the lowest point in the scale of American civilization. Close beside it the Guatemalan plateau with its drier, less debilitating climate, less dense vegetation, and relative absence of malarial fevers, is far in advance of it, although inhabited by practically the same race and governed by the same laws. Formerly the reverse was true; the plateau was, relatively speaking, only moderately advanced; that is, it was a provincial region, while the lowland was for many centuries the seat of a culture equal to that of the highest races of the eastern hemisphere before the days of Greece. In the last 1,500 years, more or less, there has evidently taken place a change of great magnitude. In explanation of this change three possibilities present themselves. First, the Mayas may have possessed a degree of energy and initiative and of resistance to fevers and to the debilitating influence of the torrid zone much in excess of that of any other known people. Second, in their day tropical fevers of the more destructive types may have been unknown in Central America; and, third, the climate may have changed. All three theories are probably true in part, but there is no independent evidence as to the first two. On the other hand, alluvial terraces and their relation to such ruins as Copan furnish strong independent evidence of climatic pulsations during the past 2,000 years. We are therefore led to conclude that although the Mayas were a remarkable people they did not of necessity excel all other races in their resistance to disease and in their power of overcoming the obstacles of a habitat—lowland forests in the moister portions of the torrid zone. In their day, apparently, the earth's climatic zones were shifted somewhat equatorward, so that in winter the conditions of the dry subtropical zone of high pressure and perhaps the rainless fringes of our cyclonic storms prevailed in the country. The yearly dry season thus produced, probably prevented the growth of dense forests, made agriculture possible, greatly reduced the amount of disease and acted as a direct stimulant by relieving the deadening monotony of the almost unchanging moist heat. A relatively slight climatic change such as this would alter the physical environment of Peten from exceedingly unfavorable to relatively favorable, and would render the location of the highest native American civilization rational instead of almost inexplicable.

Further Considerations on the Origin of the Himalaya Mountains and the Plateau of Tibet: T. J. J. See, A.M., Ph.D.

Dana's Contribution to Darwin's Theory of Coral Reefs: William Morris Davis, Sc.D., Ph.D.

It is fitting on the hundredth anniversary of Dana's birth to call attention to a significant contribution that he made many years ago to Darwin's theory of coral reefs, all the more because, although it has high confirmatory value, it has been strangely overlooked by most students of the coral island problem. Darwin, as is well known, explained barrier reefs by an upgrowth of the corals of fringing reefs during a slow subsidence of the central island on which they were established; but he did not offer any direct confirmatory evidence of the truth of his fundamental assumption of subsidence. Dana furnished independent confirmatory evidence of the assumption by pointing out that the central islands of barrier reefs are, as far as he had descriptions of them, characterized by embayed coast lines, precisely such as must result if they had subsided; all of their valleys are invaded by the sea and converted into bays. Darwin had noted this fact, but had not perceived its significance, probably because he did not understand that the embayments of a coast line are in nearly all cases formed by the submergence or drowning of preexistent valleys. Dana was the first observer in the world to bring forward this explanation, to-day everywhere accepted, and the first also to apply it to the central islands of barrier reefs. In recent years several Australasian observers have resurrected Dana's idea, and have found in it, as he did, a strong confirmation of Darwin's original theory.

The Formation of Coal Beds: John J. Stevenson, A.M., LL.D.

Cambrian Fossils from British Columbia (illustrated): Charles D. Walcott, Ph.D., Sc.D., LL.D.

Dr. Walcott gave illustrations of a very remark-

able and ancient fossil fauna discovered by him in the mountains of British Columbia, 2,000 feet above Field, on the Canadian Pacific Railway.

The fossils are most beautifully preserved and include such delicate forms as medusæ (jelly fishes), holothurians (sea cucumbers), finely preserved marine shells of various kinds and a large variety of crustaceans. Some of the latter are so perfectly preserved that the branchia, legs and alimentary canal are shown, and even in several forms the liver is so perfect that the ramifications of the tubes through it are reproduced by photography and thus illustrated by lantern slides.

Altogether over 80 genera of invertebrate fossils have been found from a bed not over 5 feet in thickness. They are all of marine origin and lived at a period when there were no vertebrates (fishes, reptiles, mammals) in existence.

The Alleghenian Divide and its Influence upon Fresh-water Faunas: ARNOLD E. ORTMANN, Ph.D., Sc.D.

Although it is well known that the Allegheny Mountains form a general boundary between the aquatic forms inhabiting their western and eastern slopes, particulars about the relations of the two faunas were missing. In fact, the fundamental facts, the actual faunas of the various streams, chiefly in the mountains, were unknown.

The writer furnishes first these facts for a number of aquatic forms of life, chiefly the fresh-water mussels, the Pleuroceridæ and the crayfishes, covering the region from the New York-Pennsylvania state line to the northern boundary of Tennessee. The main results are, that the groups mentioned have not been transported over land to any extent, and consequently are apt to furnish evidence as to the former drainage conditions. The Allegheny Mountains have acted most of the time as an effective barrier to the dispersal of fresh-water life, surely so since the end of the Cretaceous. The Atlantic side received its fauna from the Interior Basin, but not across the mountains, but around their northern and southern ends. A few instances are known, where single species have crossed the divide, and these cases are found in two sharply-restricted regions: they are probably due to stream piracy.

Neutralisation and Elimination of Toxic Substances: OSWALD SCHREINER, Ph.D.

Progressive Evolution among Hybrids of Œnothera (illustrated): BRADLEY M. DAVIS, A.M., Ph.D. Introduced by Professor John M. Macfarlane.

Certain cultures of hybrids between *Œnothera biennis* and *Œnothera grandiflora* have presented in the second generation a high degree of progressive advance in flower size and in the size of the leaves and the extent of their crinkling. A hypothesis for such progressive evolution is offered by the Mendelian principle of recombination of factors for large size on the assumption of multiple factors for the dimensions of organs, but this hypothesis also demands the presence in the same culture of groups of plants containing the factors for small size. When in an F_2 generation there is a considerable group of plants with flowers larger than those of the larger parent there should also be expected corresponding groups with flowers as small or smaller than those of the smaller parent. This follows on the Mendelian law of the conservation of factors by which the factors contained in an F_1 hybrid must all come out in an F_2 generation, provided that this generation is sufficiently numerous and that the formation and mating of gametes present no exceptional features. In F_2 generations of about 1,000 and 1,500 plants, respectively, there were no groups of plants with flowers as small as or smaller than those of *biennis*, the small-flowered parent. There were thus no groups to balance the large proportion of plants with flowers larger than those of the *grandiflora* parent. The cultures as a whole presented a marked advance in flower size.

A similar situation was presented by the character of the foliage in certain F_2 generations. The leaves throughout the mass of these cultures were much larger than those of the parents and generally much more crinkled. There was thus a marked progressive advance in leaf size with the absence of small-leaved groups of plants, and it is difficult to explain the results on strict Mendelian principles of segregation according to which groups in an F_2 generation containing the factors for large leaf-size should be accompanied by corresponding groups containing the factors for small leaf-size.

There was in these F_2 generations abundant evidence of segregation as shown in a range of variation far above that presented by F_1 generations, but this range was between groups of plants with flower and leaf size much greater than those of the two parents. Thus the petals in the larger-flowered groups were 1 cm. longer than those of the *grandiflora* parent with petals 3.3 cm. long, and the flowers of the smaller groups were two or more times larger than those of the *biennis* parent with petals 1.3 cm. long.

Certain of the F_2 generations presented classes

of dwarfs in proportions as high as 1:9 and 1:5.7. These classes were sharply separated from the mass of the cultures and there were no intermediates between the two groups. The high proportions suggest the 1:5 ratio which might be expected if two factors for size were present, each allelomorphic to its absence. Such a simple explanation, however, calls for the appearance of corresponding classes of giants to balance the dwarfs and for several other classes of plants of different sizes composing the mass of the cultures; such classes were not found. The dwarfs then present a puzzling phenomenon not readily understood on current Mendelian views of the segregation of factors governing size.

Admitting the complexity of the situation when such an extreme cross is made as that between *Œnothera biennis* and *Œnothera grandiflora*, there still appears to the writer sufficient reason in the data at hand to present the problems as material for reflection on the Mendelian theory of the stability of factors and the principles of their distribution unchanged in the organization of gametes. The question naturally arises whether the phenomenon of the progressive advance exhibited in the F_2 generation of these hybrids as well as the formation of groups of dwarfs may not involve, as a result of the cross, the direct modification of factors for size.

Climatic Areas of the United States as Related to Plant Growth (illustrated): BURTON E. LIVINGSTON, Ph.D. Introduced by Professor John W. Harshberger.

This paper deals with that phase of plant geography which relates the distribution of the various forms of vegetation to climatic factors, a phase which is as important to scientific agriculture as it is to what is commonly termed pure science.

Following an introductory consideration of the nature of the problem to be dealt with and some remarks on the sort of means by which we may hope to obtain quantitative information upon the relation of plant growth to climatic conditions, attention is given to the subdivision of the United States into climatic areas more or less susceptible of quantitative definition. Climatic conditions, as far as they influence plants, must be considered mainly as two comparatively distinct groups of environmental factors. The first of these groups constitutes the moisture conditions, tending to furnish the plant with water or to withdraw moisture from its tissues. The second group, the temperature conditions, tend to increase or decrease the temperature of the plant body. As a primary duration factor for the attempted integration or averaging of these climatic conditions, the length of the frostless season is introduced; for practically all animals and perhaps for most other plant forms in the United States, the conditions which are effective during the frostless season have far more influence on plant distribution than have those which are effective during the remainder of the year. Other time periods require attention, however.

From a somewhat thorough study of the climatic data which are at hand it appears that any two systems of isoclimatic lines, one system representing the geographical distribution of temperature conditions and the other representing that of moisture conditions, have a strong tendency to cross each other, thus dividing the country into many climatic areas, each one capable of quantitative description. The remainder of the paper concerns itself with a discussion of selected examples of these areas and of the natural vegetation which characterizes them. This line of study is in its reconnaissance stage and the results are quite tentative in their character.

The Day of the Last Judgment: PAUL HAUPT, Ph.D., LL.D.

The conception of the day of the last judgment is based on the idea of the day of the Lord in the Old Testament prophecies. Originally the judgment-day, resurrection and immortality referred to the Chosen People. The dry bones in Ezekiel xxxvii represent the Jewish nation in the Babylonian captivity. The so-called eschatological passages as well as the alleged Messianic prophecies have, as a rule, a definite historical background, but when the bills drawn on the future were not honored they were extended to doomsday.

The final chapter of the book of Joel does not contain an eschatological prophecy referring to the end of the world, but the confident prediction of an enthusiastic patriot expressing the hopes of the Maccabees for the near future. Nor does the last chapter of the book of Zachariah refer to the last judgment; originally it predicted merely a decisive victory of the Maccabees over their enemies about 140 B.C. and subsequent engineering improvements in and near Jerusalem.

The ideas of doomsday, resurrection and immortality are secondary, but Ernest Renan is right in saying that there is no lever capable of raising an entire people if once they have lost their faith in the immortality of the soul, and Dr. A. E. Garvey remarks: "He who lives for the ideals of truth,

beauty, goodness, lives not for time but for eternity."

On the Character and Adventures of Mûladora: MAURICE BLOOMFIELD, Ph.D., LL.D.

On Friday evening at the Hall of the Historical Society of Pennsylvania George Grant MacCurdy, A.M., Ph.D., assistant professor of archeology, Yale University, gave an illustrated lecture on "The Antiquity of Man in the Light of Recent Discoveries."

On Saturday morning at 9:30 o'clock an executive session was held in the hall of the society at which candidates for membership were balloted for. As a result of the election, the following new members were announced: *Residents of the United States*—George Francis Atkinson, Ph.D., Ithaca, N. Y.; Charles Edwin Bennett, A.B., Litt.D., Ithaca, N. Y.; John Henry Comstock, B.S., Ithaca, N. Y.; Reginald Aldworth Daly, Boston, Mass.; Luther Pfahler Eisenhart, Princeton, N. J.; George W. Goethals, Culebra, Canal Zone; William C. Gorgas, M.D., Sc.D., LL.D., Ancon, Canal Zone; Ross G. Harrison, A.B., Ph.D., M.D., New Haven, Conn.; George Augustus Hulett, Princeton, N. J.; Clarence E. McClung, A.M., Ph.D., Swarthmore, Pa.; John Dyneley Prince, Ph.D., Sterlington, N. Y.; Samuel Rea, Sc.D., Bryn Mawr, Pa.; Henry Norris Russell, Ph.D., Princeton, N. J.; Charles Schuchert, New Haven, Conn.; Witmer Stone, A.M., Philadelphia. *Foreign Residents*—Sir Arthur John Evans, D.Litt., LL.D., F.R.S., Oxford, England; Sir Joseph Larmor, D.Sc., LL.D., F.R.S., Cambridge, England; Arthur Schuster, Sc.D., Ph.D., F.R.S., Manchester, England.

SATURDAY, APRIL 19—MORNING SESSION

Edward C. Pickering, D.Sc., LL.D., F.R.S., vice-president, in the chair

The Potassium, Phosphorus, Nitrogen Cycles: CHARLES E. MUNROE, Ph.D., LL.D., F.C.S.

An Ammonia System of Acids, Bases and Salts: EDWARD C. FRANKLIN, M.S., Ph.D.

Some Unsolved Problems in Radioactivity (illustrated): WILLIAM DUANE, Ph.D. Introduced by Professor Arthur W. Goodspeed.

More than thirty different substances are known to be radioactive in much the same way that radium is radioactive. Most of these substances disappear more rapidly than radium does, only five of them having an average life greater than that of radium, which is about 2,000 years. The average lives of the others vary from a fraction of a second to 24 years.

The law according to which these substances disappear is the same for all of them. It may be stated thus: The rate at which any substance disappears is proportional to the quantity of that substance present, and absolutely independent of all conditions of temperature, pressure and state of chemical combination, etc. This is a very simple law, and the mathematical equations that can be deduced from it probably represent the facts as accurately as any known equations represent facts in other branches of science.

Looked at from another point of view, this law is not very easy to understand. Let us take a particular example. Suppose we have a quantity of that substance called radium emanation. The law applied to this quantity of radium emanation means: that certain atoms of emanation will explode and transform themselves into radium *A*, during the next few seconds, whereas other atoms of this same emanation will remain emanation atoms for a long time, and will not transform themselves for months to come. The question is this: How can atoms which are physically and chemically similar to each other, yet be so different that some of them will disappear immediately and others not for a long time. The explanation of this probably lies in the internal structure of the atom and not in external causes, for external conditions have no known effect upon the phenomenon.

The second unsolved problem to which I wish to call your attention is connected with the rays given off by the substances during their transformations. Some substances produce what are called α-rays and some β-rays, and other substances produce both α- and β-rays. If a particular substance produces α-rays, one and only one α-particle is ejected during the transformation of each atom of that substance, and the same is true of the β-rays. The α-particles from the same substance all have the same velocity. For instance, the α-rays from radium *C* all have a velocity of 2.09×10^9. The β-rays, however, from the same substance do not all have the same velocity. Each β-particle has one of a certain number (8 or 10) of well-defined velocities. For example, each β-particle projected from an atom of radium *C* must choose one of a certain set of velocities lying between 1.85×10^{10} and 2.99×10^{10} cm./sec.

It is difficult to understand why the explosion of an atom, say of radium *C*, which, so far as known, is just like the explosion of every other atom of radium *C*, and produces an α-ray of a

certain definite velocity, should produce a β-ray, having now one velocity and now another. Several attempts to explain this phenomenon have been made, but without complete success. Doubtless the true explanation must be sought for in the internal structure of atoms, as in the first problem mentioned above.

The third problem I will mention has to do with the γ-rays. It is known that the γ-rays are intimately connected with the β-rays, each type of ray being capable of producing the other, but the exact relationship between them is not very well understood. The particular question, however, that I wish to bring up is this: is the γ-ray a wave form spreading out as sound waves do from their source, or is it of corpuscular nature resembling the sparks projected from an exploding rocket? The fact that the velocity of the β-ray, which the γ-ray is capable of producing, does not depend upon the distance from the source of the γ-ray to the point at which the β-ray is produced seems to indicate that the latter hypothesis is correct.

The explanations of these phenomena are intimately connected with the theories of interaction of matter and electricity, and it is interesting to note that the theory, which in modern times has been of most use, the theory according to which both matter and electricity are of atomic nature, was first promulgated about 150 years ago in our own city of Philadelphia by no other than Benjamin Franklin himself, the founder of this society.

Perhaps the most important radioactive problem of practical value upon which scientists are working to-day is the effect produced by the various radiations on human tumors. Photographs were shown illustrating the results obtained in France and Germany by subjecting small superficial cancers to the action of the rays. It must be remembered that the problem of curing deep-seated malignant tumors is by no means solved.

Some Diffraction Phenomena; Superposed Fringes: CHARLES F. BRUSH, Ph.D., LL.D.

Diffraction fringes, as usually seen, are not affected by thickness or contour of a smooth, straight diffracting edge, as pointed out by Fresnel. The author finds, however, that when the fringes outside the shadow are observed within one or two millimeters from the diffracting edge, by means of a microscope, their brightness and sharpness are very greatly affected by the character of the edge. For instance, a cylindrical edge of several millimeters radius gives vastly brighter fringes than a sharp razor edge. He finds this is due to superposition of many diffraction fringe patterns which are nearly in register. They are believed to be formed by many contiguous elements of the cylindrical surface, each acting as a diffracting edge and producing its own fringes. The author further shows that the so-called "single mirror interference fringes" of Lloyd may be produced under conditions which preclude reflection, and which at the same time make it obvious that they are formed by superposition of diffraction fringes.

Matter in its Electrically Explosive State: FRANCIS E. NIPHER, A.M., LL.D.

New Investigations on Resonance Spectra: R. W. WOOD, Ph.D.

Application of Recent Studies on the Origin of the Earth's Magnetic Field to the Possible Magnetic Fields of Rotating Bodies in General (illustrated): LOUIS A. BAUER, Ph.D.

The Determination of Visual Stellar Magnitudes by Photography: EDWARD C. PICKERING, D.Sc., LL.D., F.R.S.

Ordinary photographic plates are most sensitive to blue light, while the yellow rays are those that affect the eye most strongly. Accordingly, blue stars appear brighter and red stars fainter in a photograph than to the eye. Isochromatic plates are, however, manufactured which are very sensitive to yellow light. If a yellow screen is interposed the blue light is cut off and red stars appear even brighter, relatively, than they do to the eye. By using a thin yellow screen which cuts off only a portion of the blue rays it is possible to obtain plates having the same color index as the eye. To fulfil this condition several blue and several red stars have been selected near the North Pole. Photographs are then taken with different screens until one is found which gives images of the same relative brightness as the naked eye. With the 16-inch Metcalf Telescope at Harvard, stars as faint as the twelfth magnitude may be photographed in this way with an exposure of ten minutes. With an exposure of two hours, stars can be photographed about as faint as they can be seen with a telescope of the same size. On a perfectly clear night a photograph is taken of the North Pole with exactly 10 minutes' exposure, then similar exposures on four different regions, then a second time on the North Pole, on five other regions, and a third time on the North Pole. The twelve plates are developed together and various precautions taken to secure uniform results. The magnitudes of numerous stars near the North Pole have been measured with great care and the mag-

nitudes of stars on the other plates can thus be determined on the same scale.

Some Problems in Connection with the Milky Way as shown by Photographs with a Portrait Lens: EDWARD E. BARNARD, Sc.D., LL.D.

The Spectroscopic Detection of the Rotation Period of Uranus: PERCIVAL LOWELL, LL.D., and V. M. SLIPHER, Ph.D.

By means of the spectroscope, it is possible to measure the speed of approach or recession of a luminous body; for the lines of the spectrum are shifted toward the violet or red in proportion as the body moves toward or from the observer. Hence, if the image of a rotating planet be so thrown upon the slit of the spectroscope that one end of the slit is illuminated by light from the approaching side of the planet and the other end by light from the receding side, the lines will be tilted through an angle which measures the speed of rotation.

In this way, from spectrograms obtained at the Lowell Observatory in 1911, the authors determined the rotation of the planet Uranus about its axis to take place in ten hours and fifty minutes, in a direction opposite to that of the rotation of the planets nearer the sun. Thus, for the first time, an authentic determination of the rotation of this planet has been made by a direct method.

On the Spectrum of the Nebula in the Pleiades: V. M. SLIPHER, Ph.D.

Two photographs of the spectrum of the faint nebula near Merope, a bright star in the Pleiades, were obtained in December, 1912, with a slit spectrograph attached to the Lowell 24-inch refractor. The two plates were exposed five and twenty-one hours, respectively. They agree in showing a continuous spectrum crossed by the dark lines of hydrogen and helium, the spectrum of the nebula being a true copy of that of the brighter stars of the Pleiades. The light of the nebula is thus shown to be of stellar origin. As it seems improbable that a mass of stars, all of the same spectral type as the Pleiades, should so group themselves behind the Pleiades as to give the appearance of a nebula, the author believes it more probable that the nebula consists of diffused material surrounding the stars and shining by reflected star light.

This is the first successful observation ever published upon the spectrum of this faint nebula.

Eclipsing Variable Stars: HENRY NORRIS RUSSELL, Ph.D. Introduced by Professor William F. Magie.

Progress of New Lunar Tables: ERNEST W. BROWN, M.A., Sc.D., F.R.S.

SATURDAY, APRIL 19—AFTERNOON SESSION

Edward C. Pickering, D.Sc., LL.D., F.R.S., vice-president, in the chair

Presentation of a portrait of William W. Keen, M.D., LL.D., president of the society, by Joseph G. Rosengarten, A.M., LL.D., on behalf of the subscribers.

Vice-president Pickering accepted Dr. Keen's portrait on behalf of the society.

The rest of the session was occupied by a symposium on Wireless Telegraphy and Telephony, during which the following papers were read:

Radiated and Received Energy: LEWIS W. AUSTIN, Ph.D. Introduced by Professor William F. Magie.

Mathematical theory indicates that the energy radiated from a radiotelegraphic antenna proportional to the current in the sending antenna, to the height of the sending antenna, to the height of the receiving antenna, inversely proportional to the wave-length and inversely proportional to the distance between the two antennas. Since the loudness of signal is proportional to the square of the current in the receiving antenna, the signal falls off as the square of the distance between the two.

This law has been verified by the experiments made by the United States Navy Department between the new high-power station at Arlington and several other stations situated in and near Washington.

Observations at distances over 100 miles show that in addition to the diminution in intensity of signal with the distance, there is an absorption either in the atmosphere or ground such that at a distance of 1,000 miles over salt water with a wave-length of 1,000 meters the received current is only approximately 1/25; that is, the received signals are reduced to about 1/600 of what they would have been had there been no absorption.

The absorption decreases as the wave-length is increased, so that for communication over great distances, long waves, 4,000 to 7,000 meters in length, are used, while for short distances of a few hundred miles short waves are better since they are radiated more energetically. These facts apply to daylight communication only, which is in general regular, night ranges, though greater than day, being freakish and uncertain. The absorption over land is much greater than over water, especially for the shorter wave-lengths.

In recent tests between the Arlington station and the scout cruiser *Salem* on its voyage to Gibraltar and return, messages were received from Arlington in the day time on the *Salem* up to a distance of 2,100 nautical miles, and at night as far as Gibraltar.

A comparison was also made of the action of two types of sending sets, one being the regular spark sending set and the other set in which the waves are produced from an electric arc. It has been claimed that the continuous waves emitted by the arc are less absorbed than the broken-up trains of waves produced by the spark. Up to 1,000 miles no difference in the absorption was observed, but at 2,000 miles the observations indicated that the received arc energy was relatively four times greater than that of the spark.

Resonance in Radiotelegraphic Receiving Stations: George W. Pierce, A.M., Ph.D. Introduced by Professor Arthur W. Goodspeed.

A New Form of Resonance Circuits: Michael I. Pupin, Ph.D., Sc.D.

The International Radiotelegraphic Conference of London and its Work: Arthur Gordon Webster, Ph.D., LL.D.

The great development of wireless telegraphy and the embarrassment arising from interference in communication and the refusal of different companies to transmit messages at sea led to the necessity of international control, and brought about the Conference of Berlin in 1906. It was then decided that these conferences should be periodic, and the second one was held in London in June and July, 1912. The United States sent a delegation of twelve members, representing various departments, including the army, navy and commerce and labor. The working of the conference was described, and the strong personnel of the representatives of the more than forty countries represented. All governments except that of the United States, owning the telegraphs, are able to exercise absolute control, and were represented by high officials of their post-office and telegraph administrations, as well as by military officers.

The work of the conference was concerned mainly with the questions of prevention of interference between different stations, of increasing the safety of vessels and of the prevention of abuses in improper competition, the latter being a matter in which this country was not interested. The question of interference occupied the major part of the time of the conference. Two standard wave-lengths were adopted, which were made obligatory, so that there could be no excuse for not hearing messages. The amount of power to be used was limited, so that it should not be in the power of one station to drown out others. On account of difficulties in crowded waters like the English channel, surrounded by several nations, strict rules of precedence were established and the multiplication of useless calls was restricted. Attempts to overreach one country by powerful stations belonging to another caused considerable feeling and were regulated.

In the interest of security, all stations are to be licensed by their governments. Operators must also be licensed, and shall be of two classes, according to proficiency. Operators of the second class are to be permitted only on small ships, and as substitutes on those having one operator of the first class. The wireless stations are put under the authority of the officer in command of the ship. On passenger ships there must be a special emergency plant capable of operation independently of the ship's power, and strong enough to reach eighty miles. Such stations must listen for distress calls for ten minutes of each hour. High-power shore stations must periodically cease transmitting, in order not to interfere with distress calls. Distress calls are given absolute preference. The transmission of meteorological news is facilitated by giving it priority, when sent to certain designated designations.

The author expressed the opinion that in spite of all that had been done, before the next conference, to be held in Washington in 1917, wireless traffic would have so increased that much more stringent regulations, as well as improved methods of tuning, would be necessary.

A general discussion followed, led by Professor Elihu Thomson.

At the annual dinner on Saturday evening, at the Bellevue-Stratford, over one hundred members and guests were present, the toasts being responded to as follows:

"The Memory of Franklin," by His Excellency the French Ambassador.

"Our Guests," by Professor Arthur Schuster.

"Our Institutions of Learning," by Professor A. G. Webster.

"The American Philosophical Society," by Mr. Hampton L. Carson.

Arthur Willis Goodspeed

Philadelphia,
April 23, 1913

SCIENCE

Friday, May 16, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ON THE CULTIVATION OF THE CLINICAL SCIENCES OF DIAGNOSIS AND THERAPY[1]

In preparing this address some weeks ago, I had written the statement that the membership of this association had fortunately been spared by death from any diminution in its numbers during the past year; shortly before this meeting, however, the association has suffered the loss of two of its original members—Dr. John S. Billings and Dr. Francis P. Kinnicutt, and one of its associate members, Dr. Hugh A. Stewart.

We now enter upon the work of the twenty-eighth annual meeting. Each annual session begins with an address from the president, by by-law limited to half an hour, and by custom including, first, an expression of appreciation of the honor of presiding over the assembly, and, second, suggestions for the promotion of the welfare of the association and, more especially, for the adaptation of its functions to the ever-changing conditions of American medicine.

My first duty is, then, to give thanks. The president of the association would indeed be guilty of ingratitude were he to omit to thank his colleagues for the honor and distinction they confer upon him by his election. Even though the choice comes automatically in serial sequence to members of the council, to be chosen as this officer is an honor which an ambitious physician might well be willing to look forward to as a possible culminating event

[1] Address of the president before the Association of American Physicians, Washington, May 6, 1913.

in a life of distinguished service in the profession. In the present instance, the selection has obviously been made rather as an encouragement to future work than as a reward for past performance; I can only be grateful for the generosity shown me and for the powerful stimulus to worthy effort which such confidence begets.

Turning now to the work of the association itself, it is plain that the great changes which have taken place in medicine since the foundation of the society in 1886 have modified old needs as regards associations and created new ones. Our attention has been called repeatedly to the changing needs by our presiding officers, most emphatically, perhaps, by Dr. Councilman in 1904 and by Dr. Adami last year.

Methods of medical education in the United States have passed through a veritable revolution. The proprietary medical schools, useful enough in their time, became insufficient and have been largely replaced by medical departments of universities, privately endowed, or aided by the states. The laboratory disciplines, under the stimulus of the great advances of biology, chemistry and physics in the second half of the last century, have experienced an unprecedented expansion, and the army of medical teachers and investigators has thus been recruited by a series of new battalions, made up of men trained in pathology, bacteriology, physiology, psychology, physiological chemistry, pharmacology, anatomy, histology and embryology. Many of the teachers and investigators in these purely laboratory branches are men limited in clinical experience to their undergraduate training; some of them, indeed, have entered upon a career in these fundamental medical sciences, after a preliminary apprenticeship in laboratories of biology or chemistry without taking even an undergraduate course in medicine. Meantime a high degree of specialization has been taking place also in the clinical branches. With the advent of anesthesia and asepsis in surgery came the opportunity for unexpected divisions of labor in surgical fields, while the introduction of instruments of precision, and of the methods of pathology and bacteriology, of biology and chemistry, in the work of internal medicine led to the intensive development, by skilled workers, of its various special domains.

One result of the almost explosive progress in the purely laboratory branches, has been to place the clinical subjects, and especially internal medicine, in almost an embarrassing situation. Internal medicine is, of all the biological sciences, the one to which the largest number of other sciences contribute facts for application. Internal medicine is usually designated as one of the "applied sciences." But all the sciences, with the possible exception of mathematics, are largely "applied science." Thus, physics consists in part of applications of mathematics; chemistry of applications of mathematics and physics; biology of mathematics, physics and chemistry; physiology of physics, chemistry and biology, and so on, with avalanche-like increase of the sciences to be applied, until internal medicine is reached with all the laboratory subjects offering it their aid.

Now each of these sciences, though largely applied science, is compelled to grow in its own way; each science is creative and has to devise methods of its own; even when a new fact in a science basal to it is applicable, the application has actually to be made. Take physiology as an example. A new discovery in physics, or in chemistry, does not enrich physiology until physiology makes use of it; indeed it may long lie unapplied since its fruitful application in physiology involves a physi-

[illegible] research. The number of phys-[illegible]ical and biological facts as yet [illegible] to physiological problems is so [illegible], and the number and powers of [illegible]ical workers relatively so limited that progress, though rapid, in physiology, can by no means keep pace with that of its underlying sciences, no matter how desirable this may seem.

The clinical subjects are similarly situated though in transcendent degree. It is almost a wonder that the clinician is not suffocated by the physical, chemical, biological, anatomical, physiological, pharmacological, pathological, parasitological and psychological facts which are being heaped upon him with clamor for their application. Moreover, the facts have arrived so suddenly that they find the clinician, in many instances, unable to understand them, much less to apply them. Certain chemical, physiological and anatomical facts the clinician of the last generation had, indeed, trained himself to apply by study in the post-mortem room, in the histological laboratory and in the laboratory for urinalysis. But recently, and all at once, the air has become thick with applicable facts of the most diverse origin, and only the younger clinicians have had opportunity for securing a training permitting of an understanding of even a part of them.

For some years past, students have been entering the clinics for instruction after three or four years of education in the methods and facts of the basal sciences from physics to pathology. They have been surprised to find, in many instances, their clinical teachers relatively unacquainted with the present-day content of the laboratory disciplines, and have often been astonished at the delay in attempting to apply in clinical studies facts of those laboratory branches which seem to them obviously applicable to the work of diagnosis and therapy. Such personal observations by students working in the clinics have been a sharp spur to clinical men, and have undoubtedly gone far toward accelerating the application of laboratory facts and methods in the study and treatment of the sick. At times, of course, criticisms have been too severe or unjust. Students are prone to be harsh critics; their "young hot blood tingles to be up and doing"; often they know little of the circumstances which delay progress. In certain regrettable instances students may even have been led by a zealous but ill-informed pre-clinical teacher to believe that the workers in the clinical branches are not to be regarded as "scientific," but rather as "merely practical" men. This is an attitude occasionally assumed—happily less often now than a few years ago—by representatives of various sciences to all sciences to which they contribute facts for application, that is, to all sciences except those which are basal to their own. I can recall the time when an occasional teacher of physics, or of chemistry, hinted that the representatives of physiology or of physiological chemistry were amateurish or unscientific because the work in these branches is subject to conditions often inconsonant with profitable measurement in dynes or with graphic representation of stereochemical conceptions. But the older may well profit from the criticism of the younger, even if it be arrogant or unjust. The veteran, when taken to task by the recruit, may be amused, but if wise, instead of being offended, he will listen and will try to rejuvenate himself. In any case, he will rejoice in the vigor and optimism of the youth, and a part of his reward will lie in the consciousness of helping to train a group of successors who will surpass him.

It has been interesting to observe the attempts which have recently been made more fully and rapidly to utilize the new knowledge in the underlying sciences for the furthering of the work of diagnosis and therapy in the clinics. On the one hand, the older clinicians have heroically endeavored to acquaint themselves with the new facts as they have appeared; and they have hastened to surround themselves in their wards and in the clinical laboratories with younger men, trained in the newer laboratory methods, men who could aid them in the work of clinically applying the new facts. And, on the other hand, several universities have recently appointed to important clinical positions men who have been trained predominantly in the laboratory branches and who have made their early reputation in pathology, physiology, anatomy or chemistry, rather than in the clinical sciences. In these instances, we see two methods used to overcome a great difficulty and both are laudable. Each of them has led to advances in clinical teaching and research, but each of them is subject to obvious disadvantages. In the one instance, the clinical problems may be in the foreground, but insufficient personal acquaintance with the newer fundamental facts to be utilized limits vision; moreover, the lack of machinery for the utilization of the newer knowledge hampers the organization of diagnostic and therapeutic investigation. In the other instance, there is a real danger of an underappreciation of the nature, significance and scientific importance of the problems of diagnosis and therapeusis as such; the clinical appointee especially when untrained, or only slightly trained, in clinical work, and previously nursed in a fosterage, perhaps unfamiliar with, or even mildly disparaging of, the work of the clinic and of clinicians, may feel actually ashamed to work at the bedside and in the laboratory at truly clinical problems, feeling that his former colleagues, to whom he may owe his appointment, will regard him as a scientific clinician only when he avoids researches bearing directly upon diagnosis and therapy and devotes his energies to the solution of non-clinical problems, the attack on which properly belongs to the laboratories of pathology, physiology or chemistry.

The situation is gradually righting itself. The non-clinical scientists realize better than they did what clinical work is and should be, and that workers in clinical branches should not be expected to leave their own fields to conduct other researches any more than the clinician can expect the anatomists or the physiological chemists to solve either the diagnostic and therapeutic problems of the clinic or the fundamental problems of physics and mathematics. All are acknowledging that the problems of diagnosis and therapy are tasks set by the patients themselves, that these living patients are, primarily, the objects of study of the clinical scientist. For this study a fine imaginative vision—properly schooled and rigidly controlled—is desirable. Patients must, in each generation, be looked at with fresh eyes, intellectualized partly by accurate training in the most recent clinical technique, partly by previous education in the methods, facts and hypotheses of the non-clinical sciences. It is gratifying that clinical men themselves, including those with extended training in one or more of the non-clinical sciences, are, more than ever before, recognizing the worth and dignity of diagnosis and therapy as sciences *per se*—that is to say, as bodies of knowledge to be increased, not merely as arts to be practised—sciences to be cultivated for their own sake as intensively, as proudly, and as enthusi-

astically as are the more basal sciences. And this is why clinical men are seeing to it that provision is made in the clinics themselves, not for the presence of patients only, but also for elaborate machinery for investigating them; they are demanding and equipping *in each clinic* a number of laboratories in which physical, chemical, physiological, pharmacological, bacteriological, psychological and other methods and facts can be directly applied by trained men in the diagnostic and therapeutic inquiries to which the conditions existing in the patients actually before them lead.[1] And, in addition to the more permanent staff, they are taking with them to the bedside and to the adjacent experimental laboratories of the clinic groups of medical students, trained in the basal medical sciences and making them responsible for the large amounts of routine work of which these students are capable while they are acquiring their early clinical experiences. To obtain proper facilities for clinical study and especially the multiple laboratories manned by skilled workers necessary in each clinic, not only will much money be required, but also an awakening of the understanding of the clinical men themselves, of non-clinical medical scientists and of hospital superintendents and trustees to the need. By many it is still thought that the laboratories of the non-clinical sciences can be called upon to do the laboratory work of the clinical sciences. By others, and especially by the superintendents of general hospitals (who are forced rigidly to limit the expenditure of money), the fallacy is still cherished that a "general clinical laboratory" in the hospital can best do the work of all the clinics for them. This, it seems to me, is a grave error. I am convinced that nothing short of multiple special laboratory divisions *for the direction of which each clinic is itself actually responsible,* will ever satisfactorily supply the needs. Any other arrangement will emasculate the individual clinics and paralyze research in diagnosis and therapy. It was for a precisely similar independence for physiology that Purkinje had his great struggle about the beginning of the last century. The university faculty, and the university Kurator put great obstacles in the way. They did not see why physiology should not use the other laboratory (anatomy) for the work. The Kurator sarcastically asked "where will it lead to, if every scientific branch demands its own laboratory?" Thanks to Purkinje's clear vision and his persistence, and through the influence of Goethe and Alex. v. Humboldt, physiology finally got its independent institute. Von Ziemssen recognized a similar need for the medical clinics and demanded a "clinical institute" for teaching and laboratory researches in addition to his hospital wards. Only after such salutary conditions as those referred to have been realized in the clinics, and have been maintained there for a time, can we hope to breed a generation of clinicians in any way approaching the next necessary and realizable type—a type resulting from the fusion of training in accurate clinical observation with training in the solution of clinical problems by experimental work in the laboratory. The goal stands clearly in the view of those of us who are familiar with the present conditions and are ambitious for the advance of clinical knowledge. That this goal is being rapidly approached should be a consolation to the generation of clinicians chafing under the limitations of the period through which we are passing, more than one member of which has felt keenly the truth of the adage that "the

[1] *Cf.* "The Organization of the Laboratories in the Medical Clinic," *Johns Hopkins Hospital Bull.*, 1909, XVIII., 193–198.

man who rings the bell can not march in the procession."

The state of affairs to which I have referred has, to a certain extent, been reflected in the membership, and in the programs of the meetings, of this association. In 1886, the membership was made up chiefly of clinicians with a sprinkling of laboratory workers. In 1899, of 118 members, some 18 were pure laboratory workers who saw no patients at all. At present of 131 members, some 32 are pure laboratory workers who do not see patients, and many more are largely engaged in experimental work. Of the associate members, from whom our new members are in the near future to be drawn, at least one third are men who do not study patients but are engaged entirely in laboratory teaching or research.

A glance over the program of the meeting of 1899 shows that three non-clinical and twenty-seven clinical papers were presented. Last year, the program listed some thirteen non-clinical and some forty-six clinical papers. Our program this year includes some fourteen non-clinical and some fifty-one clinical papers.[3] A large proportion of the papers classed as clinical are reports of combined bedside and laboratory work. Now, on the whole this must be regarded as a very gratifying showing, illustrating, as it does, the great expansion in our clinics of work by experimental methods, as contrasted with work by more purely observational and statistical methods.

None welcomes, nor confides in, the experimental method more, perhaps, than I, but the observational method also deserves ever new application in clinical work. Is it not conceivable that we may actually retard progress in diagnosis and therapy if we center investigation in our clinics and in their laboratories upon problems far removed from the conditions observable in the sick? May it not be desirable to plan that the experimental work in the clinics shall, for the most part, bear directly upon the problems of diagnosis and therapy (of course, in a wide sense, including etiology, pathogenesis and prognosis), and to arrange that the more fundamental physiological and experimental pathological inquiries be relegated to those laboratories, the particular business of which is to advance the sciences of general physiology and general pathology. Unless clinical men jealously guard their time, their interest, their energies and their materials in order to devote them to the advance of the clinical sciences, the progress of diagnosis and therapy must be slowed. Not that a clinician may not become so interested in pathology, physiology or physics as to make it justifiable for him to leave the clinic and occupy a non-clinical post. The clinics can only be proud to send occasionally a Helmholtz to physiology, as chemistry may be glad to contribute an Ostwald to philosophy. A man must go where his cerebral cortex leads him, be it from physic to physics, as in Helmholtz's case, or from crystallography to therapy, as in Pasteur's. Moreover, even in truly clinical investigation there will often be non-clinical by-products of great scientific value to which there can be no objection provided the main product corresponds to the aims of the clinical sciences. But, at this time, it would seem important to emphasize that researches in general physiology and in general pathology, valuable and desirable as they are for the progress of the medical sciences, as a whole, pertain to a field other than that which the clinics themselves should predominantly cultivate. May I illustrate by an analogy? Were our physiol-

[3] In making this arbitrary division into clinical and non-clinical papers I am guided by the direct relationship of the topic to the diagnosis and treatment of disease in human beings.

ogists to devote their time chiefly to the inquiries now pursued in the university laboratories of physics and chemistry to the neglect of their own physiological studies, the science of physiology would undoubtedly suffer. Now, none the less will scientific clinical work suffer loss if the men who are presumably cultivating the clinical sciences of diagnosis and therapy overlook their own legitimate problems, neglecting their clinical material to dissipate their time, and their energies, in the general or special non-clinical inquiries which properly belong to the more fundamental laboratories. The Wassermann reaction may be primarily worked out in a non-clinical laboratory, but the determination of its real significance for the diagnosis and treatment of disease demands, subsequently, long years of clinical research. Salvarsan may be made, and its spirillocidal power tested, in experimental non-clinical laboratories, but its application and value in the treatment of the different forms of syphilis are problems upon which the clinics have only begun to work—problems the full solution of which may be slow in following upon the initial non-clinical investigations.

And this brings me again to our membership and the programs of our meetings. The mingling of clinicians (who study patients and who do experimental work in laboratories on clinical problems) with non-clinical experimental workers is stimulating, I believe, to both and *I trust that this association will always contain both.* Certainly, our non-clinical members have been and now are the very flower of our association. It must be remembered, however, that the anatomists, the physiologists, the biological chemists and the pathologists and bacteriologists now have their special societies, but that practitioners, teachers and investigators of internal medicine have their principal representation in this association, and it has always been taken for granted that this association is mainly, though not exclusively, a society for workers in internal medicine (in the broad sense). In selecting new members, ought we not always to keep this main function of the association in mind?

Again, may we not do well to pay close attention to this main function in making up the programs for our annual meetings? There is a wide-spread and growing feeling among our members that the farther removed a paper is from the examination and treatment of patients, the more acceptable it is for the program. Able clinical men have told me that they find some of the papers presented at the meetings too far removed from the fields of diagnosis and therapy to be interesting or even intelligible to them. "Those who read these papers speak to us as in a foreign language" is a complaint I have more than once heard. Such a difficulty can not, of course, with a mixed membership, be wholly overcome. But something could, it seems to me, be done to remedy what careful consideration indicates is a real detriment to the fullest success of our meetings. Better suggestions than mine will, I hope, come from other members, but two possibilities occur to me. First, might we not, while accepting some papers in general physiology and general pathology, urge that they be of a character likely to enlist the interest of clinicians and that they be presented in a form easy to understand by men who have not worked upon the special subjects with which they deal; papers in general pathology and physiology of different content might better be presented in the societies of the physiologists and pathologists. Secondly, may it not be helpful to arrange the papers on the program in groups in some such way as that adopted

this year; an individual member could then attend particular sessions, or all sessions, according as his interest and activities are specialized, or more general. A glance at this year's program shows the broad scope of the combined interests of the members of this association; and this scope is sure to become still broader as internal medicine grows and specialization in its various subdivisions increases. Thus, before long, the problems of "social medicine" are likely to engage us more than they do now. And I should like, in closing, to refer for a moment to this topic. Society at present tries, for its own welfare, to educate all citizens of the state. It may soon decide to try also to maintain the health and efficiency of all. Should society so resolve, a great extension of the municipal, state and federal medical services would become necessary to prevent disease; and the present method of treating patients at their homes would, in all probability, be largely replaced by hospital treatment. And if health should come to mean more than mere existence without outspoken physical disease—to include an abundant vitality, the capacity for joyous activity and for successful adaptation to the environment—then society, to maintain the health of its members, would have to see to it that the children born inherit bodies capable of normal responses to environmental stimuli, and further, that the various environmental stimuli to which individuals are exposed are beneficial to them and not too injurious. Such an ideal campaign for health seems at present a mere dream. But some dreams are prophetic forerunners of reality, and if we are to judge of the future by certain signs in the present, say by the institution of the *Krankenkasse* in Germany and by the movement toward a national medical service as advocated by Lloyd George in England, it may not be long before we shall, in this country, too, be taking some important steps forward in "social medicine." And when the time for this is at hand, we can be sure that this Association of American Physicians will be ready to throw its influence in the direction most helpful to society as a whole.

LEWELLYS F. BARKER

BALTIMORE, MD.

THE MEANING OF GRADUATE STUDY[1]

IT was a pleasure to me to accept the invitation tendered through your vice-president to appear before you to-night to speak on "The Meaning of Graduate Study." That it is important to every member of this club to have an adequate conception of this matter is obvious, and I shall not take time to emphasize this fact. I should like to say, however, by way of preliminary, that it is also vital to the university and to the state that both you and all the people of the state should be clear and accurate in your judgment as to the true nature and character of graduate work. On this depends, to a large extent, the success of the university and the measure of service which it may render to its constituency. I hope that the way in which your graduate study is thus vitally related to the university and to the community at large will appear with appropriate emphasis before I have done speaking.

We shall best avoid mutual misunderstanding if I state at the outset the answer which I have in mind to the question, "What is graduate study?"

In the first place it is not a further extension of undergraduate study. It is something different, not merely in degree, but rather in kind. The change from undergraduate to graduate work should be as marked as that from the high school to the university. On passing from the lower to the higher the student goes into a new atmosphere. He finds what is to him a novel attitude and point of

[1] Address to the Graduate Club of Indiana University, December 10, 1912.

view. He begins to look at science and the whole body of knowledge with anointed eyes, and presently the entire structure assumes a new aspect. The student is to be congratulated if this is accompanied by a revolution in his own mind, in his ways of thinking. If these vital inward changes do not take place there is usually little reason for his continuing in graduate work.

All graduate study which properly deserves the name involves research either directly or indirectly. It consists of three parts which are to be developed simultaneously, not successively: (1) One acquires the detailed and specific knowledge needed for research; (2) one develops the spirit of inquiry and consecration to the task of extending the bounds of knowledge—the spirit which characterizes the man of research; (3) one is inducted into the actual labor of discovery, and thus begins to experience what is perhaps the profoundest pleasure of which our nature is capable. Graduate study which lacks any one of these three elements is essentially deficient; it is not taken into account in our discussion below.

But what is research? What gives to it its central place of importance? What are the materials upon which it feeds? Let us first answer the last question.

The man of research should be free to choose his material wheresoever he will. A directing authority would ultimately be fatal to his vitality and destructive of all useful labor. But he must exercise an intelligent choice. Out of the myriads of facts in the universe selection must be made. Some are irrelevant; and these should be discarded. To determine the number of sprigs of grass on the campus or to count the lady-bugs on our planet is not research. These facts—though facts they are—have no permanent character; they do not lead anywhere.

True research consists of any one or more of three kinds of work of equal rank, as follows:

1. Ascertaining new facts of a permanent character or drawing attention to new relations among facts already known. This requires the power to direct attention to things which other people have overlooked, to separate them from the mass of facts in which they are imbedded and to study them first for their own sake and then in relation to other things. The man of research requires the power to see the mosquito on the monument and for the moment to forget the monument for the sake of the mosquito. It is so often the trivial thing which turns out to be important. It is of more concern to us to know the mosquito which holds the power of life and death than to contemplate the battle commemorated by the monument.

2. Deriving the consequences of facts already known. No fact is thoroughly understood until all its consequences are brought into review or the possibility of doing this has been clearly and definitely recognized. Indeed it is only when this has been done that we can be said to have ascertained that the thing is a fact.

3. Developing a body of theoretical doctrine, with or without reference to facts to be accounted for by it. Under this head come such matters as the Mendelian theory of inheritance, the electron theory, the mathematical theory of electricity, projective geometry.

Granting now this definition of research and its fundamental relation to graduate study as outlined above, the question arises as to when the student should begin the actual work of research. Should it be in the first year? Or, should one await a longer period of preparation in order to be better fitted for it? Probably no other subject requires as much preparation for research as mathematics, because in this the whole body of doctrine is closely connected and interdependent. Many extensive parts of it can be learned in essentially only one order. One may compare it to a tree. The trunk corresponds to the fundamental parts of the subject, the branches are the subdivisions, the remoter twigs are boundaries of present knowledge, and it is here that new truth is principally to be developed. Before one is ready for research he must ascend the trunk, so to speak, and climb out along some

vigorous branch to the twigs near its end. All this takes time. And yet, if my short experience is not misleading, this may be tentatively accomplished even in the first year of graduate study. To be sure, such early research is crude; it could hardly be otherwise. Probably one should seldom allow it to see the light of day, so far as publication is concerned. And yet to do such preliminary research is a matter of importance to the student. The power of independent thinking depends first of all on a certain natural aptitude, but it is capable of cultivation. The way to develop this power is to exercise it; and the sooner one begins the better. Too much acquisition and too little discovery undoubtedly benumb the faculty of initiative.

But how is one to get started on research with some promise of successful achievement? Is there a guide who can induct him infallibly into the inner secrets of the creative power? Fortunately or unfortunately, there is no flowered path leading through fields of research, in fact, there is no path at all; every one must blaze out his own trail.

Very few people have sufficient initiative to acquire this ability unaided, or even by the aid of books. The living instructor is usually essential. A certain body of traditional lore is passed on from generation to generation of thinkers and is never reduced to writing. One needs to draw from this source of inspiration. To acquire the power of research one needs to get close to some one who has it, to surprise him in the act of creative thinking and to learn his ways of working. No one is more pleased at this than the thinker himself, for he realizes how hard it is to transmit to others his acquisition, and yet he knows that this is the most important service which he can render. To transmit to others that elusive thing called point of view is at the same time the most important and the most difficult work of the instructor.

I have said that few individuals have sufficient initiative to acquire independently the power of research. On the other hand, I believe that there are many who may develop into successful workers if they come into intimate relations with a gifted instructor. The extraordinary success of students trained under such a man as Agassiz, for instance, is sufficient proof of this. He kindled a fire of enthusiasm which never burned out.

But why should one wish to acquire this power? The labor involved in its exercise is arduous. The material rewards are not great. The majority of one's contemporaries will not realize the importance of his work. In a little circle only, the inner circle of one's colleagues, will the labor be adequately appreciated. Therefore it is clear that whatever encouragement one has in undertaking such work must be of the higher sort, it must be ideal in its nature. To help you to see the true reasons for doing research is the principal purpose of this discourse.

First of all, what is the meaning of research to the individual who does it? What selfish end may he expect apart from the pleasure of service to his fellows? To do effective research is to know the spirit of mastery, the spirit of mastery where no one else suffers the pang of defeat. It is to develop the sense of superiority of mind over that which is not mind. It is consciously to obey the command to subdue the earth. It is to replenish it with a new creation. It is to make the universe a little fuller and richer by understanding it better.

But more than all this to the individual: he learns what it is to grow. Knowledge obtained otherwise is a sort of accumulation adhering to one outwardly; but when it is attained by independent research it is more like an integral part of one—not merely a possession, but an element of his very being. What I am saying will be made clearer by means of an illustration. A magnet attracts to itself iron filings and holds them indefinitely if they are not forcibly torn away; but however long they are kept in position, they do not become part of the magnet. The knowledge which is gotten by the usual means of acquisition is like these filings; it adheres to one externally. On the other hand, that which is discovered

through research is like the material which a plant takes up into itself in the process of growth; it becomes a part of one's essential being. Thus the work of research furnishes a means of self-development which is to be had in no other way. From this point of view to do such work will be a special privilege to one in proportion as he considers his individual development a matter of importance.

There is also a further advantage. When one has learned what it is to see a thing in the flood of light which research throws upon it, all knowledge begins to take a new appearance. The light of research reaches beyond the field in which it was kindled and illuminates the neighboring territory, and finally one's whole body of exact information. It puts one in a new world even while he is amid his old surroundings.

Let us next inquire, What is the meaning of research to the university? The way in which the reputation of the university, and consequently its power of service, depend on the character and amount of research done by its staff and graduate body is sufficiently objective to be in no danger of escaping your attention; and therefore I shall pass over this matter without further remark. But there is another thing more intimate, more subjective in its nature and more important in its influence, which, by its very closeness to your experience, may fail of appropriate recognition on your part. I refer to the atmosphere, in the academic community, which in large measure is created by your presence and work. This has a pervasive influence of a peculiar kind, and every environment which feels it is vitally affected by it. Every department of the institution is indebted to it for new tone and fresh vigor. A breath of life is infused into the undergraduate work and an inspiration otherwise unknown is felt. An institution in which pure research is regularly done has an atmosphere of its own which provides a training, even for the undergraduate who is not doing research, which can be secured in no other way. Through its students it contributes to the community at large a vital influence of far-reaching power.

It is obvious that a power of this kind may be utilized with different degrees of effectiveness. I believe that it often lies in part dormant, through the failure of graduate students to develop an appropriate *esprit de corps*. The great value to each individual of the spirit which pervades the undergraduate body is well known to all of you. A similar advantage may well accrue from the *esprit de corps* of an organized body of graduate students; and such a club as the present one is effective in contributing to this end. The wide divergence of interests in the various departments makes it harder to find common grounds of association than in the undergraduate work; but the advantages to be obtained are well worth an effort.

Again, let us ask, What is the meaning of research to the larger community of which the university forms a part? What immediate practical ends are attained? What more ideal and far-reaching results are accomplished?

It is one of the paradoxes of human progress that certain practical ends are best served by work which is laid out independently of practical considerations. It is only when one develops truth for the sake of truth itself that one takes sufficient time to forge all the links in the complete chain of theory. If the attainment of a practical end is the purpose in view minor matters which appear irrelevant will be entirely ignored, for the sake of economy of time. But if one is interested primarily in the development of science, no considerations, however unimportant they appear, are left out of account. One's esthetic sense can be properly gratified only by an all-comprehensive investigation of his subject. Consequently the man of research looks at his subject from all points of view and develops a complete theory simply for the sake of his delight in its beauty. When he has finished, it is often found that his discoveries are unexpectedly of great practical importance, sometimes directly and sometimes indirectly. Human progress owes a boundless debt to such agency.

Every science affords examples of the prac-

tical value of research to the community at large; but I shall not take time to enumerate any of these.

The chief value of science does not consist in the concrete advantages upon which we can readily lay our hands. All the beautiful results of an ideal nature which are accomplished for the individual researcher also accrue in a greater or less measure to the community at large. A new sense of mastery and adequate grasp of things pervades the general mind when the people realize that the thought of their generation is being developed in part by the men who go in and out before them. There is a feeling as of access to the inner circle of thought which is vivifying in its influence, when we know that those with whom we are associated are of the company of truth discoverers. There is a new tone to the community, and a fresh impetus to its study of the wider problems. Can any community remain the same when it receives a Newton, a Poincaré, a James, a vital man of research in any field?

This is a partial statement of the significance of research to the contemporary generation. But its influence reaches beyond the investigator's community or the political unit to which he belongs. It overflows into the whole world of thought, and thus contributes with great effectiveness to a modern movement which by many is believed to mark the beginning of a new era in human history. I refer to the widespread and universal feeling of brotherhood in man, a feeling of common sympathies and common interests which know no geographical or political or racial boundaries. The spirit of research, by its complete independence of everything which separates man from man, binds together elements of the most diverse origin into a common brotherhood in which all feel the same thrill of discovery, the same consecration to the task of extending knowledge, the same incentive to labor for human progress. It is the organizations of men of research which have the most effective international congresses; and the spirit which pervades these meetings is delightful. May we not see in this a forerunner of that day when all men will recognize the extent of their common interests, however diverse the outward forms of their life or their physical surroundings?

Whatever is of present advantage reaches out also to the future; and consequently everything which we have said so far may be applied in partial answer to the question, What is the meaning of research to the future of the human race? But such an answer is indeed partial; there are yet other essential things to add before it is made complete.

If we seek to look into the future we can succeed only by the light which is afforded by the past. Therefore let us examine briefly certain typical instances illustrating the way in which the research of one period has had its full fruition only in succeeding generations. You will pardon me if I draw these principally from the field with which I am best acquainted.

In the great days of ancient Greece her mathematicians were deeply interested in the study of the various curves which may be obtained as the intersections of a circular cone and a plane; and they developed many of the properties which belong to them, especially those of a metric nature. The incentive to this study was the esthetic delight in the body of doctrine itself; no important practical applications of their results were found—none was sought. For many generations this Greek theory of conic sections was transmitted without essential modification and without application to practical matters. Finally, through his acquaintance with this theory, Kepler was led to observe that planetary paths are a special kind of conic section; and his famous three laws of astronomy were discovered and made known. After a further lapse of time, Newton's meditations on Kepler's laws led to his formulation of the theory of gravitation, with the fundamental law of inverse squares as the basis. This in turn furnished the necessary foundation for celestial mechanics, and this magnificent structure was reared by several workers, notable among

them being Laplace. If we follow this chain further we shall find that celestial mechanics became the model for an exact science of any class of natural phenomena; and men sought to fashion the whole of mathematical physics after the same plan. It would be hard to overestimate the influence exerted in this way on modern science with all the practical consequences which it has introduced. It is fair to say that we are now reaping some of the practical benefits of the old Greek theory of conic sections, since this theory furnishes one of the essential tools by means of which our present body of science has actually been developed.

Let us take from Greek mathematics another example which illustrates the way in which the value of research is cumulative. Consider Euclid's geometry. It contains an ideal body of doctrine whose form is evidently determined by the author's delight in logical consistency and coherence. It is even yet a model according to which one fashions a careful logical exposition. As is well known, the ordered sequence of its propositions was the guide of the English philosopher Hobbes in constructing his body of philosophical doctrine.

A more recent and totally different kind of example of the value of research is afforded by Mendel's theory of inheritance. About fifty years ago Mendel was engaged in ascertaining the effect produced in various characters by crossing two varieties of peas; for the explanation of the facts which he gathered he offered a theory of inheritance which has since had a remarkable influence on biological thought. And now it appears as if results of profound importance to human progress will arise from the increased knowledge of heredity which Mendel's laws afford.

Examples of this kind might be multiplied indefinitely. The way in which practical consequences of great value have come unexpectedly from research in the past reminds us indeed that specific prediction is useless. When we notice the marvelous rapidity with which scientific facts are now gathered and compare this with the experience of the past, when we see the present magnificent consequences from the relatively meager material for work in the older time, we feel like asking, What is to be the future of research? To what grandeur will it attain? What blessing will it not bring to the human race? One does not dare to assign a limit to its possibility. How far short of the present marvels of science would have been the boldest predictions of the fathers of a hundred years ago!

A work which in the past has proved itself of so profound importance deserves adequate support in the present. Whence is such support to be derived? I wish to answer this question by saying that every unit in the world community should contribute to it. The state of Indiana should sustain her proper share of men of research, and for the further reasons which I am about to state.

That community in which research of the best quality and greatest amount is done will profit most by the total research of the world. Of course those communities which contribute nothing will in the end receive great benefit also. It will be later in coming to them and it will not manifest that vitality which characterizes it in more favored places; but it will come. A sense of fair play and a wish to profit to the fullest extent require, however, that each state shall properly support research in its own borders. Otherwise it becomes a sort of leech drawing its sustenance in part at the expense of the world at large. And no patriotic citizen can ever consent that his state shall be a pensioner on the bounty of others; it must do its part in the work of general progress.

R. D. CARMICHAEL

INDIANA UNIVERSITY

THE TENTH INTERNATIONAL GEOGRAPHICAL CONGRESS

UNDER the sunniest of Italian skies the tenth International Geographical Congress was convened on the morning of the twenty-seventh of March in the historic Aula of the palace of the Campidoglio in Rome. His Majesty,

Victor Emmanuel, honored the occasion with his presence, and brief speeches of welcome were made by the mayor of the city, by Marquis Capelli, the president of the congress, and by the Italian Minister of Public Instruction, to which welcome Professor Otto Nordenskiöld, of Sweden, responded on behalf of the delegates present.

Seldom has so attractive a program of papers been prepared as that which was mailed to geographers throughout the world; but, alas, two successive postponements together amounting to nearly two years, might well be thought sufficient to dampen the enthusiasm alike of committee and prospective guests. It is, therefore, a pleasure to be able to state that in the face of these discouraging conditions the congress was a distinct success; though probably less than it would have been had not the committee decided to adhere strictly to the original program of papers by absentees and refuse all papers offered later than October, 1912.

A partial list of well-known geographers who were in attendance includes: Bruce, Brückner, Chaix, Chisholm, v. Cholnoky, Close, Cvijic, Déchy, Gallois, Hamberg, Helland, Kövesligethy, Lescointes, Loczy, de Margerie, Nordenskiöld, Oberhummer, Peary, Passarge, Penck, Pumpelly, de Quervain, Schott, Schokalsky, Sapper, Stefanssen, Supan, Teleky, Vidal de la Blanche, Wagner and Woeikof.

Geographers of all nations vied with each other in showing honor to Admiral Peary, the discoverer of the North Pole, who represented at the congress both the Association of American Geographers and the Peary Arctic Club. The only other Americans in attendance were Vilhjálmur Stéfanssen, the explorer, who represented the American Museum of Natural History, Professor Raphael Pumpelly, Mr. H. L. Bridgeman, representing the American Geographical Society and the Geographical Society of Philadelphia, and the undersigned, as delegate of the American Philosophical Society and the University of Michigan.

As might have been expected, the congress was less notable for important papers presented than by reason of programs decided upon for international cooperation. Dr. de Quervain presented, however, a preliminary report upon his crossing of Greenland in 1912, and exhibited for the first time his final map of the route and his section across the continent. Professor Emile Chaix, on behalf of the executive committee of the commission on a collection of views to illustrate the terrestrial relief, made a most attractive presentation of the work already accomplished. Mr. Stéfanssen described the geographical features of the country traversed on his recent expedition to Arctic America, and outlined briefly his plans for an expedition to Coronation Gulf soon to be undertaken by him for the Canadian government. Captain W. S. Bruce, after giving an account of his Antarctic expedition in the *Scotia*, outlined a projected expedition which will have for its object the direct crossing of the Antarctic continent from the Weddell Sea to McMurdo Sound by way of the South Pole and the inland ice plateau to the west of the mountain ranges in Victoria Land. Professor Kövesligethy, of Budapest, described his method for the prevision of earthquakes based upon the analytical expression of the hysteresis of the earth's outer shell, with data supplied from the velocity of wave propagation. Professor Gaetano Platania described the latest eruption of Mt. Etna with quite remarkable lantern slides from photographs taken by Mr. Frank A. Perret, the American vulcanologist.

At the request of the International Commission for the preparation of the "millionth" map of the world, it was decided to hold another official conference, which will be convened in Paris before the close of the present year, to which all civilized nations will be invited to send delegates. For the present the office of the Ordnance Survey in London is to remain the official center of the enterprise, to which therefore all correspondence should be addressed. The congress approved a proposition to prepare a "Universal Geography" to accompany the millionth map, but

no plans were formulated for so pretentious an undertaking. Based upon this world map, it is proposed also to prepare an international aeronautical map of the world on scale of 1:200,000, and an official conference to determine the details is to be convened.

The delegates voted in approval of the proposition that the most important problems to be settled in connection with the international exploration of the north Atlantic Ocean relate to the size, the regional extent and the nature of periodic variations of water layers to the depth of 1,000 meters, and it was recommended to continue systematic observations upon ocean currents and upon the temperature and salinity near the surface of the sea.

The proposition of the Danish Geographical Society was approved to invite the geographical societies of Rome, Madrid, Lisbon, Geneva, London, Berlin, Vienna, New York, Paris, St. Petersburg, Copenhagen, Brussels, Amsterdam, Christiania, Stockholm and Budapest to meet in Denmark in 1914 for the purpose of organizing a World Union of Geographical Societies. A large committee was appointed with one or more members from each country possessing ancient maps of its domain, for the *refection* of these maps, these gentlemen being charged with the preparation of a catalogue to be printed in a geographical journal before the opening of the next congress. Dr. E. L. Stevenson, of the Hispano-American Society of New York, was made the representative for Spain.

Much enthusiasm was shown in approving a proposition to organize in each country during the summer vacation periods of the higher institutions of learning, international courses of instruction in geography, in which foreign savants would be invited to take part. The plan contemplates also the founding of an International Geographical Institute, the seat of which is left for later determination, this institute to direct and coordinate the studies and all geographical initiatives which have an international character.

The difficult questions concerned with the confusing duplicate place names on international frontiers (such, for example, as the Alps and Pyrenees) it was voted to refer to a commission with a view to securing the general use in each case of a single term, or, when this seems impracticable, terms which are in correspondence. After a warm discussion the proposal to add Spanish to the four official languages of the congress was definitely and decisively rejected. The eleventh international congress it was decided to hold in St. Petersburg in 1916, with a rather general understanding that the next succeeding congress would be convened in Vienna.

The social events included a reception at the palace of the Campidoglio and a complimentary dinner tendered to the delegates by the committee of organization. Delightful local excursions were made to Tivoli, Ostia, Terni and the Alban Hills; and after adjournment there were longer journeys to the Po Valley and Préalpes on the one hand, and upon the other to Naples (Mt. Vesuvius and the *Campi Phlegræii*), Sicily (ascent of Mt. Etna) and Tripoli.

The weather throughout the meeting was perfect and the campagna at its best in its spring garlands of flowers; but it may be questioned whether Rome is not, even without these allurements, too interesting in itself to be an ideal seat for international congresses.

WM. HERBERT HOBBS

April 15, 1913

SCIENTIFIC NOTES AND NEWS

PROFESSOR J. M. ALDRICH, the circumstances of whose enforced retirement from the professorship of zoology and entomology at the University of Idaho, are described by Professor Vernon L. Kellogg in this issue of SCIENCE, has accepted a position in the Bureau of Entomology, U. S. Department of Agriculture.

THE American Geographical Society has conferred its Charles P. Daly gold medal upon Dr. Alfred H. Brooks for his geological and geographical work in Alaska.

THE Georg Neumayer gold medal was bestowed upon Dr. L. A. Bauer, director of the Department of Terrestrial Magnetism of the

Carnegie Institution of Washington, on May 3, in connection with the celebration of the eighty-fifth anniversary of the Berlin Gesellschaft für Erdkunde. The medal is awarded to Dr. Bauer for his researches in terrestrial magnetism. Professor Neumayer, who founded the medal, will be recalled as the most eminent student, during his lifetime, of the earth's magnetic phenomena. The medal has not been awarded since 1906.

Dr. George H. Barton, director of the Teachers School of Science, Boston, was given a dinner and a presentation on May 9. Among those who made addresses were President Maclaurin, Professor Sedgwick and Professor Burton, of the Massachusetts Institute of Technology; Professor Woodworth and Professor Ropes, of Harvard University; Professor Fisher, of Wellesley College, and Professor Lane, of Tufts College.

Dr. Rossiter W. Raymond, of Brooklyn, was elected an honorary member of Alpha Chapter of Tau Beta Pi at a joint meeting of Tau Beta Pi and Phi Beta Kappa, at Lehigh University last week.

Sir David Gill, formerly astronomer at the Cape of Good Hope, has received the insignia of commander of the Legion of Honor, which has been conferred on him by the president of the French Republic.

The council of the Institution of Civil Engineers has made the following awards for papers read during the session 1912–13: A Telford gold medal to Mr. Murdoch Macdonald, C.M.G. (Cairo); a George Stephenson gold medal to Mr. G. D. Snyder (New York); a Watt gold medal to Mr. H. A. Humphrey (London); Telford premiums to Messrs. C. W. Methven (Durban), B. Hall Blyth, Jr. (Edinburgh), C. J. Crofts (Durban), Frank Grove (Canton), B. T. B. Boothby (Hankow), and Francis Carnegie (Enfield Lock), and the Manby premium to Capt. C. E. P. Sankey, R.E. (London).

President Wilson received on May 6 a committee of the American Medical Association, which urged a general conference to discuss plans for a federal department of public health and matters pertaining to the conservation of human life and efficiency. Professor Irving Fisher, of Yale; Dr. John B. Murphy, of Chicago; Dr. G. H. Simmons, of Chicago; Dr. L. K. Frankle, and Dr. Abram Jacobi, of New York; Dr. Harvey M. Wiley, Senator Owen, and Representatives Foster, of Illinois, and Curley, of Massachusetts, were present.

Dr. Paul Marchal, chief of the Entomological Station of Paris, professor in the Agronomical Institute of France, and a member of the French Academy of Sciences, landed in New York on the fourth of the present month. He comes to America for the purpose of studying the organization of the Bureau of Entomology of the Department of Agriculture at Washington and other organizations working in applied entomology. He will remain in the United States for two or three months. Dr. Marchal is especially well known to general students of biology and morphology on account of his remarkable researches in polyembryony. In the course of his stay he will visit most parts of the United States.

Dr. Peer Geijer, the Swedish geologist, has joined the University of Wisconsin expedition to the Lake Superior mine regions. The party consists of advanced students in the engineering college and professors. The inspection tour is made every two years. Besides Dr. Geijer, J. J. O'Neill, of the Canadian Geological Survey, and G. W. Crane, of the Missouri State Geological Survey, are of the party.

Professor W. J. Baumgartner, of Lawrence, Kansas, will conduct his fourth party of biologists to the Puget Sound Marine Station at Friday Harbor, Wash., this summer. A chartered car will leave St. Paul on the morning of June 14, and will go over the beautiful Canadian Pacific route, stopping to visit glaciers, etc. Six weeks will be spent on the coast studying the exceedingly rich fauna and flora under very favorable conditions.

Professor Henry H. Norris, head of the department of electrical engineering at Cornell University, has resigned to join the editorial boards of *The Electric Railway Journal* and *The Electric World*, of which he has been an associate managing editor for some years.

AMONG those who spoke at the dedication of the engineering buildings on May 8 and 9, at the University of Illinois, were Mr. Samuel Insull, president of the Commonwealth Edison Company; M. J. G. Panghorn, special representative of the Baltimore and Ohio Railroad; Mr. John Hays Hammond, mining engineer, American Institute of Mining Engineers; Mr. W. L. Park, vice-president Illinois Central Railroad; Mr. Isham Randolph, consulting engineer, Chicago, and Governor Edward F. Dunne.

MRS. CHRISTINE LADD FRANKLIN, of New York City, gave last week at Columbia University and is giving this week at Harvard University three lectures on "Color Vision."

ON April 7, Dr. Haven Metcalf, of the Bureau of Plant Industry, lectured at the University of Wisconsin on "The Work of the Government in Forest Pathology."

THE Linacre lecture of Cambridge University was delivered by Dr. Norman Moore on May 6 in the lecture room of anatomy and physiology, New Museums. The title of the lecture was "The Physician in English History."

SIR J. ALFRED EWING gave a lecture on the structure of metals before the Durham Philosophical Society on May 2.

A COMMITTEE has been formed, with the king of Italy as president, to establish suitable memorials of the late Professor Giovanni Schiaparelli, the distinguished astronomer.

THE teachers of the Normal School at Avignon, of which M. J. H. Fabre, the entomologist, was a pupil, are taking steps to erect a monument in his honor. The council of Vaucluse has voted 1,500 francs to the fund.

MR. SHINOBU HIROTA, who recently returned to Japan after assisting Professor Milne for eighteen years in his work in seismology, died on April 24.

THE British government intends, as we learn from *Nature*, to ask parliament to sanction a special vote sufficient to provide as follows: For Lady Scott (in addition to the Admiralty pension of £200 per annum for herself and £25 per annum for her son, until he reaches the age of eighteen) an annuity of £100. For Mrs. Scott, the mother, and Mrs. Campbell and Miss Grace Scott, the sisters, of Captain Scott, a joint annuity of £800. For Mrs. Wilson, the widow, and Miss Mary Souper, the sister-in-law, of Dr. E. A. Wilson, a joint annuity of £300. For Mrs. Evans, the widow of Petty Officer E. Evans (in addition to the pension and allowances awarded to her by the Admiralty, amounting to 13s. 6d. a week), a further annuity of 12s. 6d. a week for herself and 8s. a week in respect of each of her children up to the age of eighteen. The government of India, in the service of which Lieutenant Bowers was before joining the expedition, has offered to provide pensions, amounting in all to £100 per annum, for his mother and sisters. Captain Oates, the fifth member of Captain Scott's southern party, was unmarried; and as no mention is made of any relatives, it may be assumed that he was possessed of ample means. In addition to the provision referred to, the total amount subscribed by the public as a memorial for the dead explorers and kindred purposes is £55,760.

THE surgeon general of the army announces that preliminary examinations for appointment of first lieutenants in the army medical corps will be held on July 14, 1913, at points to be hereafter designated. Full information concerning these examinations can be procured upon application to the "Surgeon General, U. S. Army, Washington, D. C." The essential requirements to secure an invitation are that the applicant shall be a citizen of the United States, shall be between 22 and 30 years of age, a graduate of a medical school legally authorized to confer the degree of doctor of medicine, shall be of good moral character and habits, and shall have had at least one year's hospital training as an interne, after graduation. The examinations will be held simultaneously throughout the country at points where boards can be convened. Due consideration will be given to localities from which applications are received, in order to lessen the traveling expenses of applicants as much as possible. In order to perfect all necessary arrangements for the examination,

applications must be completed and in possession of the adjutant general at least three weeks before the date of examination. Early attention is therefore enjoined upon all intending applicants. There are at present forty vacancies in the medical corps of the army.

THE International Association of Medical Psychology and Psychotherapy will hold its annual meeting at Vienna on September 18 and 19, immediately before the opening of the Congress of German Men of Science and Physicians.

MINING students of the University of Illinois will hold a mining exhibit in connection with the dedication of the Mining Laboratory on May 8, 9 and 10. This will consist of a display and demonstration of the heavy mining machinery and apparatus of the new building.

THROUGH the cooperation of the Bermuda Natural History Society and Harvard University, the Bermuda Biological Station for Research will be open this summer as usual for about six weeks, from the middle of June till August. Botanists or zoologists wishing to avail themselves of this opportunity should communicate with Dr. E. L. Mark, 109 Irving St., Cambridge, Mass.

DURING the months of July and August the facilities of the Seed Laboratory of the Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C., will be available as far as space permits to any one who wishes to consult the seed collection and become familiar with the practical methods of seed testing for mechanical purity and germination. For further information address Mr. E. Brown, botanist in charge.

SECRETARY DANIELS has withdrawn the offer of warships for the use of college students because of the new plans for the Atlantic fleet. Sending the fleet through the Mediterranean will make it necessary to use some of the ships, now in reserve, for various details. Consequently there will be none left that will be available for the use of college men.

AT the recent annual meeting of the Naples Table Association for Promoting Laboratory Research by Women, the use of the table supported by the association at the Zoological Station at Naples was granted for the coming year to Dr. Rhoda Erdmann, of Berlin, Germany, and Dr. Caroline Thompson, professor of botany at Wellesley College. The Ellen Richards research prize of $1,000 for the best thesis written by a woman on a scientific subject embodying new observations and new conclusions based on independent laboratory research in biological, chemical or physical science, was awarded to Miss Ida Smedley, London, England, D.Sc., London University, who has been working for the past four years in the biochemical laboratory of the Lister Institute of Preventive Medicine. The subject of the winning thesis was: "An Investigation into the Methods of Formation of Fatty Acids from Carbohydrates in the Organism." Ten theses were submitted in competition. The examiners for the award of this prize were: Dr. W. H. Howell, Johns Hopkins Medical School; Dr. Theodore Richards, of Harvard University, and Dr. Henry Crew, of Northwestern University. The following officers were elected:

President, 1913–14—Miss Ellen F. Pendleton, president of Wellesley College.

Treasurer, 1913–14—Mrs. Elizabeth L. Clarke, a trustee of Smith College.

Secretary, 1913–16—Mrs. Ada Wing Mead, of Providence.

THE Utah Eugenics Society met on April 3, for permanent organization, having existed under temporary organization since May 20, 1912. The committee on permanent organization reported constitution, by-laws, and recommendations to the meeting and nominations for officers. After a short program, consisting of talks on various phases of eugenics by Mr. Mathohniah Thomas, Professor E. C. Gibbs, of Salt Lake High School, Mrs. Martha C. Jennings, matron of women, Salt Lake City High School, Dr. E. D. Ball, of the Agricultural College, the following officers were elected:

President—Mathohniah Thomas, Salt Lake City.

First Vice-president—J. C. Wheelon, Garland.

Second Vice-president—Dr. Fred Taylor, Provo.

Secretary and Treasurer—Dr. E. G. Titus, Logan.

Members of the Council—Mrs. Martha C. Jennings; Professor Jacob Bolin, Salt Lake City; Dr. E. G. Gowans, Ogden.

IT is stated in foreign journals that the scheme for a canal to open through communication between the Black Sea and Baltic by linking the systems of the Dneiper and Duna seems now in a way to be realized. It is said that the necessary capital of 450 million roubles will be supplied by a foreign country, and that official permission for the commencement of operations will at once be given. Great hopes are entertained of the commercial development likely to ensue from the making of the canal, which will open up an important route for the export not only of Russian corn, but of timber, ores, petroleum, etc., as well as for the import of coal. It is pointed out that the railway freight across Russia is at present some 20 kopeks per pood, to which some 4 or 5 kopeks must be added as sea-freight to Hamburg or England; that the southern sea-route from Odessa involves a freight of 7 or 8 kopeks, with an additional sum of anything up to 6 kopeks for railway transport to Odessa; whereas the freight from Kherson to Riga is reckoned at only 3 to 5 kopeks per pood by the canal now to be constructed. Another important scheme lately put forward is for a canal to open communication between Central Russia and Siberia by linking the systems of the Volga and Obi-Irtish. The proposed route would make use of the Chusov and a tributary, on the west of the water-parting; and the Reshotka, Isset and Tobol on the east, thus entering the Irtish close to Tobolsk. The length is 1,100 miles, and the waterway is designed to take vessels of 5½ feet draught and a length of 350 feet. The general question of the development of Siberian waterways will shortly, it is said, be investigated on the spot by a commission of engineers.

ACCORDING to *The British Medical Journal* an institute for Medical Research in South Africa is being established at Johannesburg on the southern portion of the ground lying to the west of the general hospital and to the south of the fort. There has hitherto been no medical research institute in South Africa. A veterinary institute was erected and equipped by the government some time ago at Dasbort, eight miles from Pretoria, but though the need for a medical research institute has been pressed by members of the medical profession, financial objections have prevented any forward movement. Recently, however, the government and the leaders of the mining industry collaborated, with the result that generosity on both sides has provided not alone for the building and equipment, but also its maintenance. The new institute at Johannesburg is to serve the whole of South Africa and will be called the South African Institute for Medical Research. The industrial diseases of the Transvaal will probably first call for consideration, owing to the mortality which they have occasioned, but the work will not be limited to these diseases, and it is hoped to attract skilled workers from Europe to aid the director in his researches; it is probable that research fellowships will be available for suitably qualified medical men desirous to carry out special lines of research. The proximity of the institute to the general hospital, which is the largest in South Africa, and the fact that it will be equipped with four wards, with twenty or thirty beds for the treatment of patients, will serve to associate the institute with medical work in Johannesburg. When the institute is in full working order it is probable that courses in bacteriology and pathology will be arranged for medical students. Two appointments have already been made to the staff. The director of the institute is Dr. Watkins-Pitchford, and the statistician, Dr. G. D. Maynard. Dr. Watkins-Pitchford was formerly house-physician to St. Thomas's Hospital, London; he studied plague in India, enteric fever in South Africa during the war, smallpox in London. For the last ten years he has been government pathologist and analyst for Natal, and last year was transferred by the union government to

Johannesburg. Dr. Maynard was formerly M.O.H. for the suburbs of Pretoria, and subsequently assistant medical officer to the Witwatersrand Association. It is expected that the building will be completed in about a year.

The British secretary of state for the colonies has, as we learn from *Nature*, appointed a commission to study the nature and the relative frequency of the fevers occurring amongst the Europeans, natives and others in West Africa, especially with regard to yellow fever and its minor manifestations.

M. Jules de Payer, as we learn from foreign exchanges, has furnished particulars of his projected Arctic expedition, which is intended to leave France in the summer. With the support of the government and various societies, he will follow his father, the distinguished explorer, in making for Franz Josef Land. One of his objects is to locate the margin of the polar basin to the northeast of that archipelago, an investigation which, if successfully carried out, will provide data for an estimate of the relative areas of the basin and the continental shelf in that quarter of the Arctic region. A scientific staff will accompany M. de Payer, with equipment for the prosecution of research in all the various departments which have become associated with polar work; among them the investigation of the upper atmosphere by means of kites is specially indicated. The party will be provided for a sojourn of one year or longer in the north, its ship returning in the meantime. It is to be provided with two aeroplanes, the utility of which as instruments in polar research will be observed with interest: a visit to the pole itself is mentioned as a possibility, but does not appear as a prime object of the expedition. Wireless telegraphy will be installed at the headquarters.

The Washington Academy of Sciences has held a field meeting including the region of Cape Henry and Yorktown, which left Washington by a special steamer on April 25 and returned on April 27.

The regular monthly meeting of the State Microscopical Society of Illinois was held on April 10, 1913, at the rooms of the Chicago Press Club. The subject for the evening was "Bacteria, with Practical Demonstration in preparing Slides and Cultures," by Margaret Grant, A.M., M.D. At this meeting final reports of the recent soiree by the society and the Academy of Sciences, held in the academy building, Lincoln Park, were submitted, showing that there were twelve hundred persons in attendance. Sixty-one microscopes were in charge of forty-eight exhibitors.

UNIVERSITY AND EDUCATIONAL NEWS

The board of regents of the University of Nebraska, at its annual meeting, voted a general increase in salaries of deans and professors, distributing thus the $35,000 additional maintenance voted by the last legislature.

The faculty of the Ohio State University has adopted an arts-agricultural course, five years in length. The first three years, students will be registered in the Arts College; the last two years, in the Agricultural College. At the end of the fourth year, the degree of bachelor of arts will be given, and at the end of the fifth year, the bachelor of science in agriculture.

The Phi Beta Kappa elections for the year at the University of Wisconsin indicate that women students excel men in scholarship, as twenty-two of the thirty-six elections were women.

Professor Oskar Bolza, of the University of Freiburg, is to offer courses this summer at the University of Chicago on "Linear Integral Equations" and "Functions of a Complex Variable." Other graduate courses in mathematics are announced on "Fourier Series," "Linear Continuum and Point-set Theory" (Moore); "Projective Geometry" (Bliss), and "Modern Theory of Analytic Differential Equations" (Moulton). Dr. F. A. Lindemann, of the University of Berlin, is to lecture throughout the summer quarter at the University of Chicago on "Kinetic The-

ories." Other graduate lecture courses in physics are announced on "Relativity" (Lunn), "Wireless Waves" (Kinsley), "Radiation Theories" (Millikan).

DR. FRANKLIN D. BARKER has completed ten years of service in the University of Nebraska and has been made a full professor, having charge of the work in medical zoology and parasitology in the department of zoology.

DR. IRA D. CARDIFF, professor of plant physiology and bacteriology in Washington State College, has been appointed head of the department of botany. Professor John G. Hall, of the South Carolina Agricultural College, has been appointed professor of plant pathology in the same institution.

To the professorship of bacteriology in Columbia University made vacant by the death of Dr. Philip Hanson Hiss, Dr. Hans Zinsser, professor of bacteriology in Leland Stanford University, has been appointed.

DISCUSSION AND CORRESPONDENCE

UNIVERSITY LIFE IN IDAHO

TO THE EDITOR OF SCIENCE: Professor J. M. Aldrich, professor of zoology and entomology in the University of Idaho (Moscow), has just been summarily dismissed without trial or official warning after twenty years of faithful and successful service. The conspicuous incidents connected with this matter are few, simple and suggestive. They are the following:

In 1900 James A. McLean, a young Canadian, came to the University as president and director of the agricultural experiment station. He was a doctor of philosophy from Columbia in economics. He found the duties of director of an agricultural experiment station bewildering and uncongenial.

In 1904 Professor Aldrich with five other members of the faculty protested to the board of regents that the president was incompetent for his place. Strangely neither the president nor the protesting professors were dismissed but a compromise was effected which endured for eight years. It may be inferred from later occurrences that despite the long and healing lapse of time, the criticized president did not forget nor forgive his critics.

In 1912 President McLean left Idaho to become the president of the University of Manitoba. Before he left he made out, and gave to the board of regents, a list of professors who ought to be dismissed.

Near the end of 1912, Idaho did away with all separate boards for its various educational institutions and put its whole system in charge of a single new board. The law enacting this provided that the old boards shall hold their last meetings in the following spring.

In April, 1913, President McLean, of the University of Manitoba, crossed an international boundary and the boundary of decency and in secret session with the acting president of the University of Idaho made up a list of seven undesirable professors which list was presented to the dying board of regents and promptly acted on. All were dismissed. At the end of the meeting the board died, and its victims received their malodorous notices of dismissal two days after the board had been defunct. Thus Professor Aldrich and six colleagues have enjoyed the peculiar experience of being removed from their positions on the recommendation of a citizen of Manitoba by an official board which passed out of existence before the victims knew what had happened to them.

An appeal to Governor Haines of Idaho has resulted in an official statement that the regents acted entirely within their authority.

No comment seems necessary on these interesting incidents. Professor Aldrich, who is an unusually competent entomologist, and a peculiarly prepossessing and attractive man, will of course have no difficulty in finding work elsewhere. Will Idaho have as little difficulty in getting as good a man to fill his place?

VERNON L. KELLOGG
STANFORD UNIVERSITY, CALIFORNIA

EDUCATIONAL STANDARDS AT AN AGRICULTURAL COLLEGE

PERFECT freedom in the expression of ideas and opinions is born of one of two conditions, either full information, or lack of informa-

tion. Any other condition suggests the advisability of caution. Dr. Pritchett in his letter to the Iowa Board of Education speaks with a freedom and confidence suggesting the most intimate acquaintance possible with the ideals, the strength and the attainments of colleges of agriculture. The prescription which he gives appears within itself to follow the most searching and conclusive diagnosis.

Dr. Pritchett's diagnosis consists of two main parts: first, agricultural education, at least for Iowa, should be of a trade school standard and type; and second, agricultural education must be isolated from other lines, particularly from engineering.

Regarding the first of these specifications Dr. Pritchett says:

> The school of agriculture ought to teach preeminently the trade of farming, even though it does research in its experimental station, and conducts certain classes of high order, its primary function ought to be not the training of agricultural teachers, but the training of farmers, and the cultivation of the means by which the scientific knowledge in a practical form can be put into the hands of farmers. The great part of the work is not on a professional plane. Students of agriculture ought not to be required to comply with the same academic standards as those who expect to enter the profession of engineering. . . . In my judgment the interests of agriculture will be subserved by making the agricultural college a straight-out school of agriculture, with entrance requirements suited to the needs of those who wish to become practical farmers. I should not make these academic requirements for admission higher than the equipment afforded by the elementary schools.

This at least has the merit of being explicit. Dr. Pritchett would take the boy at the same stage of development required for entrance into the freshman year of the high school, and after getting him into this so-called college would teach him how to farm. The objections to this academic program are many, but possibly an illustration may serve the purpose. A man concerned in educational matters in Tennessee had been converted to the agricultural point of view. He made no such mistake as to go to the people with messages of chemistry, botany or zoology, but on the contrary advocated eminently practical measures. At a meeting up in the hill country he made an address in which he labored long and arduously to prove to the audience that every boy, and every girl, should know how to milk a cow, and to this end should attend an agricultural college. After wearing himself and the audience pretty well out he threw the meeting open for remarks and discussion. After a painful silence, a gaunt old man with hay-colored whiskers, the principal of a theological seminary, arose. "Stranger," said he, "I agree with you that every boy, black or white, should know how to milk a cow. I even agree that every girl should include this art along with her other accomplishments. However, I want to make this suggestion: Wouldn't it be a good thing for a college to teach its students something that a calf couldn't beat 'em at?"

If the farmers send their sons to the agricultural college in order that they may learn how to farm there are going to be a lot of disappointed farmers. At Wheaton, Illinois, plowing matches are held each fall and men who never saw a college do plowing so nearly perfectly that only those experienced in the accomplishment are able to act as judges. This skill could be learned at college, no doubt, but why run a college for teaching an art which can be learned readily in connection with farming operations? The college could no doubt develop great proficiency in the art of husking corn, but it is doubtful whether it could out-do boys who never so much as finished the country school. There are hundreds of men in Iowa who can feed cattle so successfully that few colleges would care to compete with them in the results to be obtained as judged in dollars.

What the farmer should, and does, demand of the college is a solution of the problems which are too intricate for him to solve for himself. The farmer can put fat onto steers about as rapidly as can a college professor, but he can not analyze feeds. Neither can the farmer analyze his soils or identify the pests that infect his crops. Should the college

undertake to teach these things along with the practise of farming to a lad just out of the eighth grade? Manifestly not, and for the reason that to him that hath shall be given. Few of the well-prepared boys who enter college make good scientists. Almost none of those entering Dr. Pritchett's ideal school would be able to comprehend scientific problems at all. They would go back to the farms because unprepared for any of the more advanced lines of agricultural work.

Dr. Pritchett believes that the Iowa State College has turned out more lawyers than farmers. It is too bad to break down a system of beliefs by ruthlessly intruding the facts, but the information at hand shows that about two fifths of the recent graduates of the agricultural courses are engaged in actual farming, while only 5 to 7 per cent. are in non-agricultural work. But few of the graduates have become lawyers. Until the demand for teachers and experimentalists is met it is hard to comprehend where they are to be trained if not at agricultural colleges. It is also difficult to see how these men could be more useful to the state by working a farm than by teaching the sciences pertaining to farming, editing farm papers, or testing hypotheses concerning the application of science to agriculture. This answer must be either that all scientific research is now complete, or else that scientific research is not worth while, since, forsooth, the agricultural college should make its main work the teaching of the art of farming.

The second thing needful in realizing Dr. Pritchett's ideal in agricultural school effort is isolation. This needs no discussion, since the grade of education he has in mind certainly could not flourish in a college, alongside of, and on a par with, real college work. However, the world is big and there is a place for the grade of instruction which the doctor has in mind. In fact it is being offered in the numerous short courses at the college and over the state. There will be more such short courses in the future, but the college will hardly go out of business in order to make room for them. It is not improbable that county agricultural high schools, or even township schools may, in a way which the college could not, meet the needs which Dr. Pritchett has in mind. Something of the sort has been begun. In Europe this kind of instruction is common, but the agricultural colleges are not sacrificed in order that it may be done. On the contrary, they furnish the teachers and a large part of the subject matter for the courses given in the lower grade schools. A paragraph from Dean Bailey, of Cornell, often called a prophet in agriculture, will not be amiss:

> An internal danger is the giving of instruction in colleges of agriculture that is not founded on good preparation of the student or is not organized on a sound educational basis. Winter-course and special students may be admitted, and extension work must be done; but the first responsibility of a college of agriculture is to give a good educational course; it deals with education rather than with agriculture, and its success in the end will depend on the reputation it makes with school men.

B. H. HIBBARD

A CALL FOR AMPLE AND TRUSTWORTHY VITAL STATISTICS

THE appeal of Dr. J. Madison Taylor, published in SCIENCE, October 11, 1912, for a more general and critical body of human statistics is one which should elicit a ready response upon the part of scientific men generally. No one who has had occasion to investigate a problem involving data of human history but can confirm the deficiencies to which Dr. Taylor refers. Something over a year ago the present writer began an inquiry relating to educational betterment which led to a search of various documents such as yearbooks, census reports, reports of the Bureau of Education, etc., and it soon became apparent that these sources were noteworthy for what they did not contain. In other words, they were woefully lacking in just that class of data which were vital to the inquiry in hand. An inquiry as to the existence of personal and family records soon revealed the fact that here, even more than in the other sources, except in rare instances, it was almost impossible to discover data of any adequate or reliable character.

The importance of such data in their rela-

tion to various problems of human interest is too well known to call for argument. However, it may not be amiss to cite a few incidental phases of such interest, and among them the following are especially important. Maudsley long ago ("Pathology of Mind"), emphasized its importance in relation to questions of insanity.

When we are told that a man has become deranged from anxiety or grief, we have learned very little if we rest content with that. How does it happen that another man, subject to exactly similar causes of grief, does not go mad? It is certain that the entire causes can not be the same where the effects are so different; and what we want to have laid bare is the conspiracy of conditions, internal and external, by which a mental shock, inoperative in one case, has had such serious consequences in another. A complete biographical account of the individual, not neglecting the consideration of his hereditary antecedents, would alone suffice to set forth distinctly the causation of his insanity.

It is hardly necessary to say that what is stated in this case has become greatly more certain in the light of manifold facts of current knowledge.

But important as is such knowledge in its bearing upon insanity as a malady to be cared for or treated, it is even more important in its possible relations to social and economic problems. It is no part of the purpose of this brief paper to deal with these phases of the subject. The problem which has concerned the writer is that of eugenics in relation to educational betterment. With many who have been concerned in the present status and tendencies in educational progress he has had a growing conviction that conditions are deplorably bad in many respects, and in some matters the situation is grave to a degree not generally realized. It is not the ranting criticism of hasty reformers and radicals of quixotic type which is the occasion of concern. But those who know best the situation, those who are upon the inside, the friends of the best in educational tradition and inheritance, have been among the critics, and have not hesitated to cry aloud and spare not. Then, too, we have had opportunity to "see ourselves as others see us." Our system of education has been designated as a "*Proliferating Mediocrity.*" It is thrown into our teeth that the present generation has added little or naught to literary, or philosophic, or scientific greatness; that we take none of the Nobel prizes for scholarly achievement; that American schools are glorified chiefly as a *theoretical system.* To such arraignment we may, or may not plead guilty, according to our points of view. This is not the place to discuss the pros or cons. Conditions have provoked the challenge and criticism. It is serious enough to give us pause, and to awaken inquiry and analysis. Assuming there are possible grounds for criticism, that our so-called system is not perfect, that a tendency to mediocre results exists, what can be done in the matter? And further, what has all this to do with vital statistics?

Considering first the last feature, let it be noted that had there been gathered during the century past a body of school statistics of a critical and informing character we should be in possession of just the data which would enable us to answer some of these questions in a more thorough and convincing manner than is possible without them. It is very well to glorify the values of education by pointing to distinguished jurists, statesmen, educators and others, as products of Harvard or Yale or Oxford, etc., but it may still be open to query whether *all this is so!* The cynic will retort "They were great in spite of this, that or the other college!" And who has convincing evidence for or against?

But this is not the only, or chief, call for statistics. There has long been current, as a sort of creedal tenet, applicable to all sorts of social or civil or religious or educational conditions, the adage *all men are created free and equal!* But deductions of science and sociology have later been declaring the very opposite, that men are created under bondage and to inequality through laws of heredity and variable environment. So far as education is concerned it may be assumed as beyond reasonable debate that the armies of idiocy, imbecility, feeble-mindedness, to mention no

others, prove the latter conclusion all too convincingly.

But among the educable none who has had practical experience with the problem is likely to espouse the older tenet. Limitations and inequalities are obvious conditions, not for the schools alone, but for every vocation or avocation of human life. Now, in theory, all this has been quietly ignored. We have framed our curricula, whether of kindergarten, school or college, on the older assumption. There have been *radicals* at work on the curricula of schools for delinquents and imbeciles, and the latter view of human nature has been unhesitatingly accepted as settled. But not so in the schools for normal and subnormal children. Here we still adhere to the older assumption; and while the dunce-cap or the rod may have passed as an index of our inherent faith in our creed, still there are other evidences of the integrity of our creedal loyalty! And how has it worked out in practise? The answer, at least in part, is simple and obvious. Scholarly standards have been made to suit *averages*. While a large proportion are capable of successfully achieving the general average, a considerable proportion could just as easily attain the highest rank of efficiency. But first consideration has been given to the mediocre or average class. The pupil of fine ability, of potential genius, has been allowed to drift, to loaf after the easy task of the average has been met in an indifferent way! And what of the backward or low grade pupil? Here too has there been the same ill-directed mechanical ideals; he has been abused, hectored, discouraged and allowed to become a part of the flotsam of ne'er-do-wells.

Vital statistics comprising such data as Dr. Taylor suggests, among which are baby records of growth, development, physical and physiological peculiarities, etc., including also data of early childhood and its distinctive traits and idiosyncrasies, would furnish a first discriminative basis for educational outlook. Following this up with similar data of kindergarten and grade schools, in connection with such devices for testing mental quality as the Binet Scale, the intelligent teacher has at command a ready means for differentiating the school work so as to insure from it a degree of efficiency which in the past has been quite out of the question. Such school statistics, made a part of the permanent records of the school, are at once available, not only as they relate to school pedigrees, but might readily become part of the vital statistics of the city, the state or the nation.

But the difficulties involved! To be sure there will be some difficulty in securing such statistics, and considerable labor as well. But they are not insuperable; they are not so difficult as may be supposed. Such data are already available in many schools. I have direct information as to the existence of such data in the schools of Pittsburgh, Rochester, New York City and others, where for several years these facts have been critically compiled and filed as a part of the records of the schools, just as are data of grades, etc. One condition which greatly lessens the supposed difficulty of such vital records is that of medical school inspection. This has now become a recognized part of all progressive school direction. And while as yet it may be chiefly concerned with such physical problems as teeth, tonsils, nose, eyes, ears, etc., yet there is no good reason why it may not include some note of mental traits, idiosyncrasies, etc. But further, it is now well known that in some of the better schools there are already provided child-study laboratories equipped with all necessary facilities for critically measuring mental qualities, among which are inquiries into heredity and antecedents.

Now to revert to the question of educational betterment. Let it be recognized at once that education is not *creator*, but *guide*. Educability is largely a question of innate mental constitution, which fundamentally is determined by brain structure and its correlations. Hitherto our only means of forming an estimate of educability has been that of experiment. Try out the subject by a dozen years of school life; then pass him on to the college; possibly what the schools failed to do some academic legerdemain of a college pro-

fessor may achieve! But the experiment usually serves only to continue through four years further a task which a brief glance through the school pedigree would have shown to be hopeless against hope. Education must in some way have its basis of selection and differentiation no less efficient than has been that of organic nature. One of the most hopeful of these means, so far as the writer can perceive, is through what may be designated as educational eugenics, the application of the principles of eugenics to problems of mind to the function of the schools, and preeminently to the college and university, in the same general way through which we are presuming to secure better social and racial germ plasms.

Assuming what is now generally conceded, that all human characteristics are inherited in probably equal degree, and this must include mental traits and aptitudes, then it is not utopian to anticipate the existence of potentialities of intellect which it may be possible to distinguish early in development, if indeed they may not be predicted on some basis such as Mendelism, and which may serve as an index of fitness for or against prospective scholastic eminence of such nature as to warrant encouragement or inhibition, as the case may be. This does not imply that all educational effort need be intercepted; to the contrary, it means rather differentiation of aims and methods. One may give no promise whatever of fitness for distinctively literary or scientific or pedagogical education, yet may be safely directed toward technical, vocational or industrial education. In other words, our program, like that of eugenics in general, should be selective in both a positive and a negative sense; fitness should be sought and fostered in every reasonable way, while the unfit should be deflected or diverted into avenues in which some outlook may prompt specialized training adapted to such betterment as may be within realization.

Let me close as I began, with a call for ampler and more critical vital statistics. They are needed in almost every phase of our complex modern social and civil life. They can be made contributory to health, to moral and social conservation, and, as it seems to me, to educational progress toward a degree of efficiency and excellence for which it will no longer be necessary to apologize or explain.

CHAS. W. HARGITT

SYRACUSE UNIVERSITY

TO TRACE THE LINES OF FORCE IN AN ELECTROSTATIC FIELD

MR. R. F. D'ARCY describes an arrangement for tracing the lines of force of an electrostatic field in *Nature*, of March 20. Mr. D'Arcy's method is to support a metal ball at the top of a tall glass tube standing upon a float in a tray of mercury. Then, according to Mr. D'Arcy, the insulated ball follows the horizontal lines of force of the electric field between the properly placed terminals of a large electric machine.

Another method for tracing the lines of force in an electric field is described by Mr. B. M. Neville in *Nature* of April 3. Mr. Neville simply allows a scrap of cotton-wool to fall between the knobs of an electric machine. As soon as the bit of cotton-wool touches one of the terminals it becomes charged and moves off rapidly along a line of force.

The most satisfactory method known to the writer for tracing the lines of force in an electrostatic field is to suspend a toothpick by fine thread from the end of a long handle. When placed in the electric field the suspended toothpick behaves exactly like a compass in a magnetic field, and points in the direction of the field.

The method suggested by Mr. D'Arcy is open to the objection that an insulated metal ball does not, in general, tend to move along the lines of force in an electric field. The objection to Mr. Neville's arrangement is that the piece of cotton-wool moves too rapidly.

W. S. FRANKLIN

HIGH SCHOOL BOTANY

THE fact that an idea is a decade old is not necessarily a recommendation for it; but if it

remains in use after that time it is evident that it has worn well in at least one person's head. The present standard secondary course in botany has been in use in a large part of the United States for somewhat more than that time. At about the time it congealed into a fixed and generally understood course, I was teaching both college and preparatory botany in the University of West Virginia. As a teacher of botany, I was naturally much interested in the subject and took advantage of every opportunity to examine its workings. At the same time, I took care that none of my own students failed to get a decent familiarity with botany as it had previously been taught in the high schools; that is, with a knowledge of the flowering plants growing in the vicinity. As to the wisdom of including the study of individual flowering plants, my opinion has grown stronger with the years.

During the last seven years I have seen and overseen a very large amount of botanical teaching, including the work of more than twenty teachers. In two high schools and in the work given students of high school grade in the College of Agriculture of the University of the Philippines, the course has been as outlined in Bulletin 24 of the Insular Bureau of Education. This course is really general botany, including the general facts and principles of morphology and physiology, including also drill in the determination of plants by means of keys, and the preparation of an herbarium of fifty determined species. In a considerable number of high schools where the teachers had had the usual first year of college botany and no other preparation in the subject, the outline in this bulletin was found not to be an adequate guide for their work, and the course given was accordingly as near as they could come to the standard high school course, with the help of one or another of the texts in most general use in the States. All possible assistance, including the distribution of numerous determined plants, was given these teachers, in the attempt to make their teaching "alive." So much depends upon the teaching ability of the teacher that a comparison of results even when judgment is based on familiarity with the subsequent work of a large number of students is not sure to be fair. But it certainly has been the case here that the students who were given instruction modeled after the standard American course have on the whole proved less interested in the subject, and less familiar with it, than those whose course had followed the local outline.

The students in the latter course get a first-hand knowledge of the plant cell, of the characteristic tissues of the higher plants, and of some of the typical plants illustrating the course of evolution. They learn accuracy, if the teacher teaches it, very much as they would in some other course. They are taught to think; enough for instance to be able to explain why the great groups of plants are characterized by their reproductive structures. They get a better idea of the variety and resourcefulness of nature than American students can be given, but this is because so many of the things we used to have to take on faith are growing about them. Also, and this is the characteristic of the course, each student becomes better acquainted with a considerable number of plants which he is already used to seeing, by determining them with a key and preparing them for his herbarium.

The teaching of botany should serve several uses. It should teach accuracy in observation and in depiction. It should help to create the habit of accurate thought. It should equip the students with a considerable amount of practical information. It should also give them an interest in the subject, which will stay with them after they get their credit and leave the class room. The standard course is essentially inadequate in two respects. It does not convey such information, which will be useful to many of those who have taken it, as it well might do. And it does not give the majority of those who take it an interest in the subject which will abide with them. The reason for the latter failure is that the course does not deal as it should do with things which are already familiar and interesting to the student, and does not include exercises of a kind which most of the students can have anything to do with after they leave school.

An interest in plants is a natural one. Plants are everywhere about us, and are useful in many and exceedingly important ways. The botanical teaching of the last ten or fifteen years has been missing its opportunity to serve and take advantage of this interest, by busying itself too exclusively with plants which most people never see except in the class room, and in which they have no practical interest.

The old course of study made better use in many respects of one term than the newer course has done of a year. It left much to be desired and the newer course made up its shortcomings; but it did this at too great an expense when it threw away the familiarity with the different kinds of common flowering plants, and the excursions, and the love of the woods which the students gained in old-time classes. There are hopeful signs of a backward swing of the pendulum. And it is well that this come before field botany is quite forgotten.

E. B. Copeland

INDOOR HUMIDITY

To the Editor of Science: Notwithstanding the conclusions reached in Dr. Ingersoll's interesting letter on this topic, something may perhaps be said in favor of a humidity considerably higher than 40 per cent., and nearer the 66 or 70 per cent. favored by "most authorities."

The writer has made experiments similar to those of Dr. Ingersoll, but with the following differences: gallons evaporated per day, 18 to 20, instead of 25 or more; volume of house actually served by the hot and humid air supply, 17,000 instead of 20,000 cubic feet; humidity maintained with comfort, over 60 per cent., instead of 40 per cent. Another important factor, and there are yet more, is that of house temperature. Unfortunately, Dr. Ingersoll has omitted any mention of this; but, judging from common American practise, one may, perhaps, assume a day temperature of 70°. Now in a Scots household, such as the writer's, a temperature nearer 60° is thought more comfortable, and was that aimed at in our experiments. And herein enters the most interesting feature of the case, that the weight of water present per cubic foot, and hence the possible amount of dew deposit, is approximately the same with 40 per cent. saturation at 70° as with 60 per cent. saturation at 60°! Thus, after all, those at least of the authorities that are European may not be so far wrong in their estimate, and, truly, one does like to say a little, if only occasionally, in favor of the authorities.

The writer would agree most heartily with Dr. Ingersoll in the statement that any serious effort to raise the indoor humidity is very well worth while.

Alan W. C. Menzies

Oberlin, Ohio

SCIENTIFIC BOOKS

The Purchasing Power of Money; Its Determination and Relation to Credit, Interest and Crises. By Irving Fisher, assisted by Harry G. Brown. New York, The Macmillan Company. 1911. Pp. xxii + 505.

Although Irving Fisher is a good propagandist and can use arguments which appeal to the man in the street, his reasoning is based upon critical, logical, scientific analysis. One of the propositions which he has recently been actively promoting is international monetary reform looking toward the elimination or restriction of those disastrously wide variations in prices which may be due to the irregularities of the world's gold production. The principles upon which his suggestions for regulating the general price level are based are expounded in his "Purchasing Power of Money." An early proficiency in mathematics and interest in the mathematical theory of prices has led him naturally to a quantitative or quantity theory of money which he builds up with a deep knowledge and appreciation of scientific method. This attitude is a justification for Science to show an interest in his work which it could hardly exhibit in the case of ordinary studies in economics.

Fisher starts from the obvious identity that what is spent per annum is equal to what is spent. If E be expenditure in cash and E' expenditure by check, we have

$$E + E' = (E + E').$$

Now if M be the amount of money in circulation, the average velocity V of circulation or rate of turnover of this money per annum may be defined by the equation

$$E = MV;$$

and if M' be the amount of deposits subject to check, the average velocity V' of turnover of deposits may be defined by

$$E' = M'V'.$$

Further, if Q_i be the quantity of a substance i which is bought and p_i the price, p_iQ_i will be the amount spent in this transaction. Total expenditure $(E + E')$ during the year will be the sum Σp_iQ_i of the various products p_iQ_i for the transactions of the year; or

$$(E + E') = \Sigma p_iQ_i.$$

This equation may be modified by the introduction of the total trade T for the year and the average price P. Then

$$\Sigma p_iQ_i = PT,$$

and the fundamental identity becomes

$$MV + M'V' = PT, \qquad (1)$$

which is *the equation of exchange*[1] (Chaps. I.–III.).

Such a mathematical identity is, as every one knows, a mere truism whose validity nobody should be rash enough to dispute. It might therefore be thought, and it is apparently the idea of many, that, being a truism, the equation is worthless, that nothing more can be obtained from it than has been put into it. This opinion has been somewhat of a stumbling block relative to all mathematics, and even such a prince of mathematicians as Poincaré did not think it beneath him, in his philosophizing moments, to try to explain why mathematics can really amount to something, why it does give results which are valuable, why it is really creative. We need not enter upon that question here; we may admit that by proper discussion and transformation *mathematical identities do reveal important* relations not obvious in the original form of the identity. Let us admit the same in regard to the identity (1).

[1] This simple form of the equation applies only to self-contained communities where each transaction is settled during the year. The author, however, discusses (p. 370 ff.) the modifications necessary when unsettled accounts and intercommunal trade are present, and comes to the conclusion that the changes are insignificant in the case of the United States.

We now have under our eyes six separate elements, M, M', V, V', P, T, entering into the equation of exchange, and we may focus our attention upon the effects produced upon certain of these elements by supposed variations in the others. For instance, if the amount of trade T and the velocities V, V' of circulation of money and deposits remain constant from year to year while the amounts of money M and of deposits M' increase, it follows indubitably that the general price level P must rise. On the other hand, if M, M', V, V' remain constant while trade increases, the level of prices must be lowered. As a matter of fact the statistics for the United States for 1896 and 1912 are as follows:

	M	M'	V	V'	T	P
1896 ...	0.88	2.71	18.8	36.6	191	60.3
1912 ...	1.70	8.15	21.0	53.0	435	107.6

If we regard the price level P as the passive element, the effect, and the other elements as causes,[2] we shall attribute the rise in the price level chiefly to the great increases in deposits subject to check and in their velocity; for the product MV has about kept pace with the increase in trade, whereas $M'V'$ has greatly outstripped it.

When it is a question of such actual figures as these, we have reached a stage somewhat remote from the equation (1) in the sense in which it was originally set up. Originally MV stood merely for the expenditures

[2] The author gives reasons to justify this assumption.

E of cash, which would naturally be impossible to calculate directly; now MV stands for an estimate of these expenditures obtained by a searching analysis of available financial data; that is, the evaluation of E is indirect. The same is true of $M'V'$ and E'. And the elements P and T are likewise found by diligent compilation and discussion of commercial data instead of by direct quest among the buyers and sellers. Such a change of aspect is found constantly in the correlation of theoretical and experimental physics. An equation is set up by a series of definitions or demonstrations. No amount of data can prove the equation; its validity is *a priori*. But the need of an experimental verification of the equation is none the less great; for in the applications to practical problems it is precisely such experimental data which must be used in the equation; and unless proper means of evaluating the terms of the equation are found, the importance of the theory is nil.

The author examines in lucid detail the various interrelations of the six elements which enter the equation of exchange. He comes to the conclusion that normally the element P may be regarded as passive, as the effect of the other elements, and that normally the ratio M'/M of deposits to circulation tends to constancy. He then goes on to an exhaustive discussion of what happens in transition periods where prices are rapidly rising (or falling) and where a certain amount of abnormality enters (Chap. IV.). The use of the word normally in the statement that normally the ratio M'/M tends to constancy seems rather unfortunate. The ratio M'/M has increased more or less steadily[3] for the United States from 3.1 in 1896 to 4.8 in 1912, and according to the author's estimate[4] for the whole gold-standard world the ratio will increase from 1.25 in 1911 to 2.25 in 1926. Thus the whole period of thirty years must be regarded as abnormal. With this use of the word it might well be that most periods are abnormal. We would not dispute that in the cycles between successive crises there should be certain periodic variations of the ratio, and that sudden changes in the world's gold production should bring about other erratic variations, and it is these two things that the author seems chiefly to have in mind; but it seems evident that a certain secular increase in M'/M should be expected to accompany normal advances in banking facilities and the attendant increase in use of these facilities by the public.[5]

The refined quantity theory of money is contained in the equation (1) where all the elements except P are considered as independent variables; it is a much cruder theory which is based upon the assumed constancy of M'/M. No careful reader of Fisher's work will fall into any crude errors or attribute such errors to the author; but there are enough careless readers, who may seize upon the phrase "quantity theory of money" and be led into useless discussion forgetful of the developments of Chaps. VIII. and XII., that we could wish the author had made less of the "normal" dependence of M' on M. Those who will but observe that in the equation of exchange for 1896 the term $M'V'$ was about six times as great as MV, and in 1912 about twelve times as great, will see the great danger and instability introduced into the system by making the preponderating term depend upon the small one.

The ascription of the rapid rise of prices during the past fifteen years to the great flood of gold has become increasingly popular of late, particularly since the impressive symposium on the subject in the first volume of *Moody's Magazine*. A facile argument may be constructed, namely, that the more gold we have relative to other possessions the less valuable is any given amount of it to us and the

[3] In the table on p. 304 the value 7.77 for M' for 1904 seems to upset the steadiness; but this number should obviously be 5.77.

[4] *American Economic Review*, September, 1912.

[5] A leading trust company says that now ten women have a check account where only a few years ago only two had one, and uses this fact to attract further accounts.

more readily will we exchange it for other goods; hence prices of other goods, as measured in gold, must rise. Such an argument does not introduce the equation of exchange; it is based on a sort of value theory of gold, partly quantitative, but largely psychological. We must not forget that according to theoretical economics the equilibrium of exchanges and the relative prices of goods do depend on the marginal utilities of the goods, that is, upon the relative values of the final infinitesimal quantities of goods entering into the exchange as these values are estimated by the individual traders. The value theory or, better, the marginal utility theory is therefore fundamental and the above mentioned facile argument is qualitatively correct.

When, however, we desire to take the equation of exchange as fundamental and for a quantitative discussion this seems the readiest if not the only thing to do, we have to examine merely the effects of a flood of gold upon the various elements of that equation. Suppose that 258 grains of standard gold are mined and turned over to the government for coinage into $10 or for exchange for a gold certificate of like amount. Then M is thereby increased to the extent of $10. As V is about 20, there is a contribution of some $200 to the product PT. If a half billion of gold were thus injected into the circulation in the United States each year, it would cause an increase of ten billion in PT. Now in recent years trade has been increasing here in the United States at the rate of some fifteen billions per year. The half billion of gold, practically the total world output per year, would therefore not suffice to maintain prices, to say nothing of advancing them, here in our own country if we added all of it to the circulation, and provided, of course, that we did not otherwise inflate the circulation.

Suppose, however, that the 258 grains of gold went into the reserves of a bank operating under a rule of 25 per cent. reserve against deposits. The quantity M' would then be swelled not merely by $10, but by $40, and as V' is in the neighborhood of 50, the term $M'V'$ would be increased by something like $2,000, ten times as much as the term MV was increased on the previous hypothesis. Hence an addition of 75 millions in gold to the reserve stocks of banks operating under a 25 per cent. ratio would swell the term $M'V'$ by the fifteen billion requisite to keep pace with trade, and a greater increase of gold would more than keep the pace, it would force prices to rise. These figures are very rough and are cited merely to enforce the idea that it is the expansion of credit by the influx of gold into bank reserves, and not the increase of gold in circulation, which must be the chief cause in the rise of prices as determined by the equation of exchange. We make no attempt to take secondary effects into consideration.

In the last chapter of the work the author discusses the possibility of stabilizing the purchasing power of the dollar, that is, of maintaining an approximately constant price level. The scheme he there suggests for accomplishing this purpose has undergone successive modifications in a considerable series of printed papers or privately circulated monographs until its present form appears in an article only two months old.[8] Unfortunately he abandons his equation of exchange and proceeds with general arguments or special hypotheses which seem far from substantial foundation. Such a change in style may be necessary to make an impression on a general public, and it is only by making such a general impression that any actual change of standard of value could be made into law; but for a mathematician the way would have been better lighted had the equation of exchange been constantly in evidence.

Briefly, the plan is to have the various gold-standard governments of the world pay less for gold as the general level of prices rises. Thus instead of giving a dollar for 25.8 grains of coin-gold, the United States would require 27 or 30 grains in exchange for a dollar. The author has an elaborately worked

[8] "A Compensated Dollar," *Quarterly Journal of Economics*, Vol. 27, February, 1913.

out plan for changing the price of gold and for preventing the government from being at the mercy of gold speculators. He gives detailed tables and charts to show what, on certain assumptions, would have been the results if his system had been in operation for certain periods of years. His suggestions have called forth a very large number of commendatory comments from a great variety of persons eminently able to judge of their value from many diverse points of view. There seems to have been but small adverse criticism from any quarter. As for ourselves, untrained in such matters and deprived of the direct guidance of the equation of exchange, we will acknowledge that a bewildering vacillation is in possession of us, swinging us now to complete confidence in the plan, and again to absolute distrust of it.

At the present moment we are extremely pessimistic about the efficacy of Dr. Fisher's remedy. Statistics show very well that the term in the equation of exchange which causes the trouble is $M'V'$. To keep prices constant we have to keep the increase of $M'V'$ sensibly equal to the increase of trade. Now if a gold miner has to take fewer dollars from the government for a given amount of gold, there is a slight diminishing of the increase of M, and if he deposits the gold certificate subject to check, there is a slight reduction of the increase of M'. But these small alterations of the increases of M or M' would make only an insignificant effect upon the equation of exchange. Of course, if the price of gold were lowered enough to shut down some of the gold mines, the effect would be of considerable magnitude, and thus ultimately the regulation might be accomplished. But this would be at a very much altered price of gold; for gold mining is a pretty profitable business. Moreover, it would probably be an extremely unstable stabilization of the dollar; we have only to look at the market for copper metal over a long series of years to see how violent are the swings of prices when regulation of demand and supply takes place through the closing down or opening up of the less efficient mines.

When the government requires more gold for a dollar all the gold certificates outstanding, though presumably redeemable in the new ratio for gold, are actually backed by less than the requisite amount. Within moderate limits there would be, as the author says, no danger in this arrangement. Indeed, there has been at times a great cry against the wastefulness of gold practised by the United States in keeping a great hoard at par with the gold certificates,[1] whereas if the gold were available for banking purposes, it would serve as the basis of an enormous credit. But this is precisely what we do not want if we are intent on keeping prices down. It would add much to the possible efficacy of Fisher's regulatory plan if the government were required to maintain all the gold certificates at par with the new weight of gold. The author, however, specifically states that this need not be required. The matter is not so important as it might be, owing to the smallness of the term MV in the equation of exchange.

What about the banks? If the government is not to keep its certificates at par with the new figure for gold, are the banks to be compelled to compute their percentage gold reserve on the new basis? If so, the scheme is not very sure of enthusiastic support from bankers. For instance, if a banker has deposits of one million dollars on which he must keep a reserve of 20 per cent. in gold, he has a reserve of \$200,000, or 5,160,000 grains in gold, at the present exchange ratio of 25.8 grains to the dollar. If the ratio is altered to 25.9 grains to the dollar and he is still required to keep a 20 per cent. reserve, he must add 200,000 grains, or \$775, at the old evaluation, to his reserve. This, so far as he is immediately concerned, is equivalent to leaving the exchange ratio for gold unchanged and raising his gold-reserve requirement to 20.0775 per cent. This would undoubtedly have the

[1] We believe we are right in saying that R. Goodbody once suggested that some of the evils of our inelastic currency system could be alleviated, if not remedied, by calling in the certificates and paying out the gold.

effect of absorbing to a certain extent the present oversupply of gold. It would scarcely be effective in keeping down the average price level until a far greater rise in the effective reserve requirement had been made.

The calculations by which the author shows that had his system been in vogue during the last few years the price level would have remained sensibly constant are based upon the assumption that a one per cent. rise in the amount of gold demanded for a dollar brings about a one per cent. fall in the price level. On a certain vague value theory of money this may appear reasonable, but from the point of view of the equation of exchange it is far from obvious. The one thing we must bear in mind is that $M'V'$ must be kept under control, and to a less extent MV. The author would have done much better to stick to his equation and calculate what effect his proposition would have had upon the changes in $M'V'$. That would have been more scientific.

Lowering the price of gold could diminish the increase of M' in three ways. First, by slackening the output. The lowering would probably have to go a long way, however, before the slackening became considerable. Second, by diverting gold from banking uses into the arts. Whether the arts, which now consume only about one third the annual output as against two thirds which goes to monetary and banking uses, could well absorb a much greater quantity of gold unless the price were very much lowered is not evident. Third, by augmenting the effective reserve requirements, as above explained. What we must have is some sort of a sink for gold. Indeed, it occurs to us to suggest that without at all disturbing the ratio of exchange between gold and dollars, we could accomplish the desired regulation of prices by insisting upon the strengthening of reserves. Suppose all banks receiving deposits subject to check were compelled to maintain a 50 per cent. reserve on all new business beginning with 1914. An increase of 15 billions in trade would then call for 150 millions in gold instead of the much smaller amount at present required. To make banking less profitable and safer might be easier and more directly effective than to discourage gold mining.

So much attention has been devoted to Fisher's plan for regulating the price level because the subject is actively under discussion all over the world, because Fisher has failed to maintain the scientific excellence with which he started out, and because he has apparently developed a method of attack which is better and surer than the one he uses. In view, however, of the almost unanimous indorsement he has received we feel very apologetic about these criticisms we offer.

Some parts of the work we have scarcely touched upon, parts which from a scientific point of view might seem to merit more notice in this weekly than the parts we have discussed. For instance, there is in Chap. X. an analysis of the best index numbers of purchasing power and in an appendix a masterly analytical treatment of the various types of index numbers which show the defects and the advantages of different types for different purposes. And in general there is much of excellent scientific value throughout the appendices. But we must pass it by, as we do much of the historical matter (Chap. VII.), and the discussion of indirect influences which exert secondary effects on the equation of exchange (Chaps. V.–VI.).

The arrangement of the book is very thoughtful toward the reader. Not only are the table of contents and the index exceptionally full, but there is a little foreword wherein readers of different types are instructed as to where they will find what they in particular are looking for. The mathematical work is relegated to the appendices, and so are the more subtle developments. The book should be read by everybody at all interested in any of the questions it treats.

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The Mesozoic Flora of Graham Land. By T. G. HALLE. Wissenschaftliche Ergebnisse d. Schwedischen Süd-polar-Expedition, 1901–

1903. Bd. III., Lief. 14. Pp. 123. Pls. IX. Stockholm. 1913.

The recent renewed interest in Antarctic exploration, the discovery of the South Pole, the unfortunate fatality attending the English expedition, etc., have focused attention on this *terra incognita*. There is in this region so much in the way of possibility as regards the origins of floras and faunas, centers of distribution, and possible migration routes, that everything which tends to throw light on its past life is likely to prove of absorbing interest, and in this connection it is a pleasure to note the appearance of Dr. Halle's splendid memoir on the Mesozoic flora of Graham Land which is the first Mesozoic flora known from the Antarctic. Previous to the work of the Swedish South Polar Expedition our knowledge of the ancient Antarctic vegetation was extremely limited. The present report is based on a very large collection made, it is said, under conditions of the greatest hardship, by Dr. J. G. Anderson at Hope Bay, Graham Land. The material came from a single series of hard, dark, slaty rocks and is regarded as Middle Jurassic in age. The flora embraces 61 forms of which, however, nearly 20 have not been given specific names. They are distributed among the several groups as follows: Filicales 25; Cycadales 17; Coniferales 16; unknown 3. It is of interest to note that the Ginkgoales, which are so important and varied an element in the northern hemisphere, are entirely absent in the Antarctic, as indeed they are in the Gondwanas of India. *Podozamites*, which is so abundant and variable in the north, is absent from the Hope Bay collection and is represented only by fragments in the Indian localities. Cycads are abundantly present at Hope Bay but they are all small-leafed species, while the conifers were abundant in materials but not well preserved.

Although the author has made quite a number of new species—on the wise basis that it is better to give a new name that may ultimately become a synonym, than to lump doubtful material under an old name that later may have to be divided—there are no less than 22 species previously known. Of these, 9 species are common to the Lower Oolites of England, 8 to the Upper Gondwanas of India, and 5 to the Jurassic of California and Oregon, with others which are scattered at various well-known Jurassic localities. The close relation existing between the Jurassic flora of Graham Land and other contemporaneous floras is certainly remarkable when considered in regard to its remoteness from these floras. In the nearest continent, South America, there are no floras of any importance that can be considered contemporaneous with the Antarctic one. Dr. Halle concludes as follows: "Though the closest argument is with the Jurassic flora of England, the resemblance to the Indian Upper Gondwana flora is nearly as great. The Hope Bay flora tends thereby to lessen yet more the differences between these floras and thus becomes another important illustration of the uniformity and world-wide distribution of Jurassic floras. This uniformity is all the more striking because of the pronounced differentiation of the world's vegetation into two different phyto-geographical provinces at the end of the Paleozoic, which difference would appear to have become almost extinguished in Jurassic time."

F. H. KNOWLTON

SPECIAL ARTICLES

THE PHYSICO-CHEMICAL CONDITIONS OF ANESTHETIC ACTION. CORRELATION BETWEEN THE ANTI-STIMULATING AND THE ANTI-CYTOLYTIC ACTION OF ANESTHETICS

THE anti-stimulating action of lipoid-solvent and other anesthetics is well known. Irritable tissues become temporarily irresponsive when exposed to solutions of these substances in certain concentrations, which must not be too high—otherwise cytolysis results, or too low—in which case irritability may be increased instead of decreased. The precise nature of the change in the irritable elements conditioning the loss of irritability remains obscure. The Overton-Meyer theory refers

anesthesia to a modification of the lipoids. But a reversible loss of irritability similar in all essential respects to anesthesia may be induced by substances which have no specific relation to lipoids—as salts of magnesium or calcium, acids in low concentration, non-electrolytes like sugar—and also by the electric current (anelectrotonus). From these facts we must infer that although a change of state in the cell-lipoids may induce anesthesia it is not the essential change. Some other more general process is involved. What is the nature of this process?

In studying the conditions of chemical stimulation in the larvæ of *Arenicola*—a free-swimming annelid trochophore, 0.3 millimeters long and abundant at Woods Hole—I was struck with the fact that solutions which stimulate the musculature powerfully, causing strong and persistent shortening to half the normal length, invariably cause an immediate and marked exit of pigment from the body cells. Among such solutions are pure isotonic solutions of sodium and potassium salts. The cells of the larvæ contain a yellow water-soluble pigment, which on death, or under other conditions associated with increased permeability of the plasma membranes (action of cytolytic substances, as saponin), diffuses into the medium and colors the latter a bright yellow. This pigment thus serves as a convenient indicator of permeability-increase. The strong stimulation caused by isotonic NaCl solution is thus associated with a marked permeability-increasing action. This is equivalent to a cytolytic or toxic action, for definite toxic effects, as shown by breakdown of cilia and failure of the larvæ to revive completely on return to normal sea-water, always follow even brief exposure to the pure NaCl solution. The stimulating, permeability-increasing and cytolytic actions of the solution thus show a definite parallelism.

Conditions that prevent the immediate stimulating action also prevent the permeability-increasing and toxic action. Addition of a little calcium or magnesium chloride, *e. g.*, to the NaCl solution has this effect. In such mixed solutions there is little or no immediate stimulation or loss of pigment and the toxic action is greatly diminished. Stimulation and permeability-increase, with the associated toxic or cytolytic action, are thus simultaneously prevented by the calcium or other antagonistic salt.

Similar effects are seen if the organisms are briefly treated with magnesium chloride *previously* to being brought into the NaCl solution. Isotonic $MgCl_2$ solution causes neither stimulation nor loss of pigment. The musculature is rapidly anesthetized in this solution, and the animals remain rigid and without contraction, swimming slowly by the cilia which remain active. If the larvæ are then transferred to $m/2$ NaCl no immediate effect is seen. Stimulation and loss of pigment are entirely absent, and correspondingly there is little immediate toxic action. The treatment with $MgCl_2$ has a protective or anti-cytolytic as well as an anesthetic or anti-stimulating (desensitizing) effect.

Similar effects are produced by lipoid-solvent anesthetics. Larvæ exposed to a 0.7 v. per cent. solution of ether in sea-water are rapidly anesthetized. If then they are brought suddenly into pure $m/2$ NaCl containing the same proportion of ether, no stimulation or permeability-increase is seen, and the toxic action is diminished as before; *i. e.*, recovery on return to sea-water is much prompter and more complete than after similar exposure to pure $m/2$ NaCl without previous anesthetization. Direct transfer from normal sea-water to ether-containing salt-solution also causes little or no stimulation or loss of pigment. The anti-stimulating action in this case also is associated with or involves a marked anti-toxic action.

I have performed similar experiments with a large number of other anesthetics with the same general results.[1] In those concentrations which in sea-water produce typical reversible anesthesia, the anesthetic checks or prevents the immediate stimulating action of the salt

[1] For a detailed account of these experiments *cf. American Journal of Physiology*, 1913, Vol. 31, pp. 264 *seq.*

solution, and also its permeability-increasing action as indicated by loss of pigment. A corresponding anti-cytolytic or anti-toxic action is invariably found to be associated with these effects.

The following anesthetics have been used in these experiments: *alcohols:* methyl, ethyl, n-propyl, isopropyl, n-butyl, n-amyl, n-capryl; *esters:* ethyl acetate, propionate, butyrate, valerianate, nitrate; *urethanes:* methyl, ethyl, phenyl; chloroform, carbon tetrachloride, nitromethane, acetonitrile, benzol, toluol, xylol, phenanthrene, naphthalene; ethyl ether, chloretone, chloral hydrate, chloralose, paraldehyde, phenyl urea, acetanilide, phenacetin, methacetin.

Almost all of these substances have also been used by Overton in his investigations of anesthesia in tadpoles. In the case of *Arenicola* larvæ the concentrations requisite for neuromuscular anesthesia are in all cases higher (usually from three to five times higher) than for the neuromuscular system of Vertebrata. Otherwise the relations observed in these experiments are closely similar to those found by Overton and other experimenters in this field. For homologous series (alcohols, esters) the anesthetic action increases regularly with the molecular weight—*i. e.*, with the lipoid-water partition coefficient. The anti-cytolytic or protective action always runs closely parallel with the anti-stimulating action. A well-marked protective effect is however often seen in concentrations which are insufficient for complete anesthesia.

The general fact that the anesthetic hinders or prevents increase of permeability indicates that the seat of its *essential action is in the plasma-membranes of the irritable tissue.* The characteristic permeability of the plasma-membranes of cells to lipoid-soluble substances furnishes strong evidence that these membranes consist largely of lipoid material. The lipoid-solvents alter the membrane by changing the state of its lipoid components; other substances may produce similar effects by changing the state of the other colloids of the membrane. In general these observations show that anesthesia is associated with an increase in the resistance of the membrane to the permeability-increasing action of the stimulating agency. I infer, therefore, that the essential condition of anesthetic action is a modification of the physical properties of the plasma membranes of the irritable elements, of such a kind that the membranes fail to undergo, under the usual conditions of stimulation, the increase of permeability essential to this process. This modification may be caused by lipoid-solvents, salts or other substances; also by altering the electrical polarization of the membrane by an external electric current, as in anelectrotonus. Apparently any condition that renders the membrane incapable of rapid and reversible changes of permeability renders the tissue refractory to stimulation. On this view the parallelism between the antistimulating and anti-cytolytic actions becomes intelligible, since increased permeability is the condition of cytolysis as well as of stimulation. Substances or conditions that prevent the one effect will also prevent the other.

These observations have a direct bearing on the general theory of stimulation. They support the view that an essential feature of the stimulation-process is a well-marked increase in the permeability of the limiting membranes of the irritable elements. It is obvious that the problem of the nature of anesthetic action involves the problem of the nature of the stimulation-process, and study of the action of anesthetics thus forms one means of attacking this wider problem. Any constant physical modifications caused in the irritable elements by the anesthetic, coincidently with the loss of irritability, must furnish indications of the nature of the processes concerned in the response to stimulation. The above observations thus agree with those of Nernst and his successors, which localize the primary or critical process in stimulation at the semi-permeable membranes of the irritable elements. They indicate further that in stimulation the permeability of these membranes is increased. But changes of permeability must involve

changes in the electrical polarization of the membranes; and it seems probable that these variations in electrical polarization are more directly responsible for the characteristic special effects produced by stimulation—such as increased oxidation, contraction, and the other forms of response which vary from cell to cell.

RALPH S. LILLIE

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THE SOUTHERN SOCIETY FOR PHILOSOPHY AND PSYCHOLOGY

THE eighth annual meeting of the Southern Society for Philosophy and Psychology was held at the Johns Hopkins University, Baltimore, on Tuesday and Wednesday, April 8 and 9, 1913. Three sessions were held: one on Tuesday afternoon, one on Tuesday evening and one on Wednesday forenoon. On Tuesday afternoon at 5 o'clock the members of the society were invited to attend the university lectures on "Bergson's Doctrine of Time" given by Professor A. O. Lovejoy in the Donovan Room of McCoy Hall. The sessions were held in the lecture room of the biological laboratory, President R. M. Ogden presiding. The president's address, entitled "The Relation of Psychology to Philosophy and Education," was given at the session on Tuesday evening. Preceding this address, the local members of the society entertained the visiting members at a dinner at the Johns Hopkins Club, and after the address they entertained them at a smoker in the rooms of Professor Lovejoy. The following items were passed upon at the business meeting, which was held on Wednesday morning:

1. It was decided to hold the next meeting at Atlanta, Georgia, during the recess of the Christmas holidays, in conjunction with the meetings of the American Association for the Advancement of Science.

2. The following officers were elected for the year 1913: *President,* H. J. Pearce, Brenau College; *Vice-president,* A. O. Jovejoy, Johns Hopkins University; *Secretary-Treasurer,* W. C. Ruediger, The George Washington University; *Council for three years,* Bird T. Baldwin, Swarthmore College, and Josiah Morse, University of South Carolina.

3. The following were elected to membership: Professor W. H. Chase, University of North Carolina; Professor L. R. Geissler, University of Georgia; Miss H. B. Hubberd, Baltimore; Miss E. D. Keller, Baltimore; Dr. Frank A. Manny, Baltimore Training School; Professor Mark A. May, Murphy College; Father Thomas V. Moore, Catholic University of America; Mrs. Jacob Taubenhaus, Newark, Delaware; Mr. Jacob Ulrich, Baltimore; Professor H. H. Williams, University of North Carolina.

4. The accounts of the treasurer were audited by a committee of the council and showed a balance on hand, April 9, 1913, of $68.70.

5. Votes of thanks were extended to the authorities of the Johns Hopkins University for the use of the lecture room of the biological laboratory and to the local members for the dinner and the smoker.

W. C. RUEDIGER,
Secretary-Treasurer

THE GEORGE WASHINGTON UNIVERSITY,
WASHINGTON, D. C.

THE ZOOLOGICAL SECTION OF THE MICHIGAN ACADEMY OF SCIENCE

THE nineteenth annual meeting of the Zoological Section met in the zoological lecture room of the University of Michigan at 9 A.M. and 1:30 P.M. on April 3, with Vice-president Peter Okkelberg in the chair. The meetings were well attended and the following program was read. Dr. Bertram G. Smith, of the Ypsilanti State Normal College, was elected vice-president and chairman of the Zoological Section for the coming year. Hereafter the meetings will be held on the Friday and Saturday after Thanksgiving.

"Factors Governing Local Distribution of the Thysanoptera," A. F. Shull.

"Results of the Mershon Expedition to the Charity Islands, Lake Huron Coleoptera," A. W. Andrews.

"Types of Learning in Animals," J. F. Shepard.

"The Lepidoptera of the Douglas Lake Region, Cheboygan County, Michigan," Paul S. Welch.

"Check-list of Michigan Lepidoptera. II. Sphingidæ (Hawk-moths)," W. W. Newcomb.

"On the Breeding Habits of the Log-perch," Jacob Reighard.

"A List of the Fish of Douglas Lake, Cheboygan County, Mich., with notes on their Ecological Relations," Jacob Reighard.

"May the Remains of Adult Lepidoptera be Identified in the Stomach Contents of Birds?" F. C. Gates.

"The Mitochondria," R. W. Hegner.

"The Unione Fauna of the Great Lakes," Bryant Walker.

"An Adult *Diemyctylus* with Bifurcated Tail," B. G. Smith.

"Notes on the Mollusks of Kalamazoo County, Mich.," Harold Cummins.

"Sarcoptid Mites in the Cat," Harold Cummins.

"The Origin of Continental Forms, III.," Howard Baker.

"An Ecological Study of the Birds of Manchester, Mich.," F. Gaige.

"Notes on Crustacea Recently Acquired by the Museum of Natural History of the University of Michigan," A. S. Pearse.

"Distribution of Multiple Embryos on the Blastoderm," O. C. Glaser.

"Nesting of Our Wild Birds," Jefferson Butler.

"The Factors that Determine the Distribution of *Boleosoma nigrum* in Douglas Lake, Cheboygan County, Mich.," H. V. Heimburger.

"Pedogenesis in *Miastor americana* Felt.," R. W. Hegner.

"The Seminiferous Tubules in Mammals," G. M. Curtis.

"A Method of Producing Cell-like Structures by Artificial Means," E. W. Roberts.

"Some Notes on Rhizopods from Michigan," E. W. Roberts.

"Oxygen and Carbonic Acid Contents of Douglas Lake, Cheboygan County, Mich.," D. A. Tucker.

"Some Observations on *Asplanchna amphora*," D. A. Tucker.

"Some Abnormalities Observed in Proteocephalid Cestodes," G. LaRue.

"Some Observations on Intestinal Villi," O. M. Cope.

"Some Physiological Changes in the Lamprey Egg after Fertilization," P. Okkelberg.

"A Collection of Fish from Houghton County, Mich.," T. L. Hankinson.

"The Lagoons and Ponds of Douglas Lake, Cheboygan County, Mich.," H. B. Baker.

"The Shiras Expeditions to Whitefish Point, Mich." (1) "Birds," N. A. Wood. (2) "Mammals," N. A. Wood. (3) "Amphibians and Reptiles," Crystal Thompson and Helen Thompson.

"Notes on the Ornithology of Clay and Palo Alto Counties, Iowa," A. D. Tinker.

"A Check-list of Michigan Mammals," N. A. Wood.

"The Variations in the Number of Vertebræ and Ventral Scutes in the Genus *Regina*," Crystal Thompson.

"An Artificially Produced Increase in the Proportion of Male Producers in *Hydatina senta*," A. F. Shull.

R. W. Hegner,
Secretary

SOCIETIES AND ACADEMIES

THE NEW YORK ACADEMY OF SCIENCES

The Section of Anthropology and Psychology met in conjunction with the New York Branch of the American Psychological Association on April 28, when the following program was presented:

Afternoon Session, at 4:10 P.M.

Mr. A. E. Rejall: "Binet Tests in Schools for Incorrigibles in New York City."

Mr. G. F. Williamson: "Some Individual Differences in Immediate Memory Span."

Miss Mabel Barret: "The Order of Merit Method and the Method of Paired Comparisons."

Dr. E. K. Strong: "Effect of Size and Frequency on Permanence of Impression."

Dinner at the Faculty Club of Columbia University, 6:00 P.M.

Evening Session, at 8:00 P.M.

Dr. Clara Jean Weidensall: "A Comparison of the Records of the Criminal Woman and the Working Child in a Series of Mental Tests."

Professor J. McK. Cattell: "Families of American Men of Science."

Dr. A. T. Poffenberger: "The Influence of Strychnine on Mental and Motor Efficiency."

PHILOSOPHICAL SOCIETY, UNIVERSITY OF VIRGINIA MATHEMATICAL AND SCIENTIFIC SECTION

The seventh meeting of the session of 1912–13 of the Mathematical and Scientific Section of the Philosophical Society was held April 22.

Mr. Justus H. Cline presented a paper by himself and Professor Thos. L. Watson, entitled "Normal Faulting in the Cambrian of Northern Virginia."

Professor Chas. Hancock presented a report on the "Plants of the Southern Power Company."

Professor J. S. Grasty read a paper, by himself and Professor Thos. L. Watson, on "Barite Deposits of the Southern States."

Wm. A. Kepner,
Secretary

University of Virginia

SCIENCE

FRIDAY, MAY 23, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

OPENING ADDRESS[1]

WE have come together especially to take note of the fact that fifty years ago a number of prominent workers in the field of science founded the National Academy of Sciences, receiving a charter from the United States government. It would be interesting and instructive to call the roll of the founders and learn who they were, but it will suffice to refer to some of the most conspicuous among these or, perhaps it would be better to say, some of those whose names are most familiar to the present generation. High up on this honor list are Louis Agassiz, James D. Dana, Wolcott Gibbs, B. A. Gould, Asa Gray, A. Guyot, Joseph Henry, J. Leidy, J. P. Lesley, Benjamin Peirce, R. E. Rogers, W. B. Rogers, L. M. Rutherfurd, Benjamin Silliman, Jeffries Wyman and J. D. Whitney. Fifty names are included in the act of incorporation. Among those are several members of the United States Army and Navy, as for example, J. G. Barnard, J. A. Dahlgren, Charles H. Davis, John Rogers, J. G. Totten, and others holding positions in the United States Military Academy and the United States Naval Observatory.

A careful scrutiny of the list of incorporators will show that they can be classified under three heads. The majority were engaged in scientific researches and had reached results of value. They were the leaders among the scientific investigators of that day. Then there were those who had gained distinction by their services as engineers either in the army or navy; and a

[1] Delivered by the president at the anniversary meeting of the National Academy of Sciences, April 22, 1913.

third class was composed of heads of national institutions such as the United States Naval Observatory, Naval Academy, Military Academy and Coast Survey.

Section 2 of the act of incorporation provides that the academy "shall consist of not more than fifty ordinary members," and that the academy "shall have power to make its own organization, including its constitution, by-laws and rules and regulations." Nothing is said in regard to the qualifications for membership. This is equally true of the constitution and rules except that Article I., Section 1, of the constitution requires that "members must be citizens of the United States." It should, however, be noted that Article IV., Section 4, of the constitution contains this clause:

> Each nomination shall, at the time of election, be accompanied by a written list of the original works of the nominee.

The reference is to nominations for membership, and the inference is clear that the nominee was assumed to have "original works" to his credit.

Whatever may have been the views of the incorporators, it has gradually come to be held that membership should stand for successful activity in the field of scientific research, the word scientific as here used meaning that which pertains to the natural sciences. But our predecessors did not intend to bind themselves to this meaning, as is clearly shown by the election of James Hadley in 1864, who, though a brilliant scholar, was certainly not distinguished for work in natural sciences; of G. P. Marsh in 1865; and later of Francis A. Walker and Richard Mayo-Smith.

As regards engineers who were prominently recognized in the early days of the academy the change of attitude that is worthy of notice is briefly this: While one who had accomplished some engineering feat was formerly regarded as worthy of membership by virtue of that fact, now the view appears to prevail that only such engineers as have advanced their subject by original contributions should be recognized.

And, finally, it is no longer held that the heads of scientific bureaus or departments of the United States government should necessarily be made members of the academy, no matter whether they have been actively engaged in scientific research or not. It is evident therefore that the field of choice has gradually become narrower.

What was perhaps regarded as the most important part of the act of incorporation is contained in Section 3 and reads as follows:

> The academy shall, whenever called upon by any department of the government, investigate, examine, experiment and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments and reports to be paid from appropriations which may be made for the purpose, but the academy shall receive no compensation whatever for any services to the government of the United States.

This clause is still valid. The United States government may at any time call upon the academy for investigations, opinions and advice on any subject of science or art and this without charge for services.

In order the more clearly to understand the situation that existed in 1863 we should bear in mind two facts. First, there were at that time but few scientific bureaus forming part of the national government; and second, it was a time of war.

Perhaps it would be better to state these facts in the other possible order. Service to the government was uppermost in men's minds. If they could not help in one way, they could in another. What more natural than this willingness to place their knowledge and skill in scientific matters at the disposal of the government? This was an

act of patriotism, and patriotism was in the air. While engineers, astronomers and mathematicians were then well represented in the works of those who were serving their country in one capacity or another, it was a difficult matter for those in authority to secure authoritative opinions and advice in other branches of science. There was a gap to be filled. By granting a charter to a group of the leading workers in all branches of science on the terms under consideration the gap was filled in a most satisfactory manner. After that act there could no longer be excuse for not seeking scientific advice whenever it was desired or needed.

How did this work? An examination of the records shows that for a number of years after the National Academy was incorporated the government perpetually called for reports. Six such reports were made in the first year of the existence of the academy. The subjects were: "On the Protection of the Bottoms of Iron Vessels"; "On the Magnetic Deviations in Iron Ships"; "On an Alcoholometer"; "On the Explosion of the Boiler of the United States Steamer *Chenango*"; "On the Use of Aluminium Bronze for Cent Coinage"; "On Wind and Current Charts and Sailing Directions." In 1865 there were two reports; in 1866, four; in 1867, two, both of which are worthy of special mention. They are "On the Improvement of Greytown Harbor, Nicaragua," and "On Galvanic Action from Association of Iron and Zinc." In 1868 there were two. In 1870 there was one report "On the Protection of Coal Mines from Explosions by Electricity"; another "On Removal of Ink from Revenue Stamps"; and a third "On Silk Culture in the United States." In 1875 and 1876 there was only one each. Then in 1878 there were several important reports—six in all—among them one "On Proposed Changes in the Nautical Almanac"; another "On the Use of Polarized Light for Determining Values of Sugars"; another "On the Measurement of the Velocity of Light" and another "On the Preservation of the Writing of the Original Declaration of Independence." While there have been important reports on important subjects since 1878, it is undoubtedly true that of late years the academy has been called upon less frequently than in the early years. At first the officers of the national government took the matter seriously, and this was to the advantage of the country. But with the multiplication of scientific bureaus supported by the government the need of help from the academy has become less and it is true that some of the subjects already mentioned, and others not mentioned, could have been reported upon by one or another of the existing bureaus had they been in existence at the time. But, even as matters now stand, there is ample room for the kind of activity which was in the minds of the founders. Large questions of a scientific character present themselves from time to time, and it is hard to conceive of a better method of dealing with such questions than that under consideration. In this connection it should be borne in mind that advice, even good advice, is not always heeded. Indeed it may happen that it is treated almost contemptuously. This is well illustrated by an actual case which deals with an important governmental problem. Owing to its importance this case may well be treated of in some detail.

The sundry civil act, approved May 27, 1908, requests the National Academy of Sciences to consider certain questions relating to the conduct of the scientific work under the United States government, and to report the result of its investigations to Congress. In order that the subject may

be clearly understood the language of Section 8 of the act referred to should be quoted:

Sec. 8. The National Academy of Sciences is required, at their next meeting, to take into consideration the methods and expenses of conducting all surveys of a scientific character and all chemical, testing and experimental laboratories and to report to Congress as soon thereafter as may be practicable a plan for consolidating such surveys, chemical, testing and experimental laboratories, so as to effectually prevent duplication of work and reduce expenditures without detriment to the public service.

A committee was promptly appointed and that committee gave serious and prolonged attention to the subject. In due time the committee submitted its report to the council of the academy. The council having approved, the president transmitted the report to the Speaker of the House of Representatives and the presiding officer of the Senate. Everything was done in proper form. The president of the academy congratulated himself on the personnel of the committee which he had appointed, upon the report and upon the fact that the academy had performed an important duty and had been, as he thought, of real service to the national government.

It were well perhaps to close the account of the incident at this point, but unfortunately the moral would be lost, and the only object of telling the story at all is to point the moral. Well, what happened next? It is not necessary to go into detail. The result was humiliating to the committee that drew up the report. That report seems to have been promptly pigeonholed. It is certain that, so far as we have any information on the subject, it was not given serious consideration by Congress. And yet whatever may have been its imperfections that report represented the views of a group of eminent men of science who had devoted much time and thought to the study of the problem before them and who at the request of the President of the United States had been given every opportunity to learn the facts. Such an experience need not dishearten. The charter still holds good, and accordingly, the academy stands ready, whenever called upon by "any department of the government," to "investigate, examine, experiment and report upon any subject of science or art." As time passes it will come to be recognized more and more clearly by those in authority that the scientific method is the one most likely to lead to results of permanent value. Briefly defined, the scientific method consists in studying the facts and then drawing the most logical conclusion from these facts. It is most desirable that our government should utilize to a greater and greater extent this method which is free from partisanship and has only truth to serve. In the long run the influence of the National Academy upon affairs of government must be felt. Far-sighted statesmen must see and do see that it is well for the country to have a body of workers in the field of science connected in some way with the government, and the day will come when this will be recognized more clearly and more generally than it is to-day. The question is not what is best for the academy? It is, what is best for the country? May we not hope that in the near future Congress will see its way clear to emphasize the importance of the connection between the government and the academy by providing it with a proper home which can serve as a center of general scientific activity? This subject has again recently been brought to the front and there is a possibility that favorable action may be taken.

By an act of Congress approved June 20, 1884, the National Academy of Sciences was "authorized and empowered to receive

bequests and donations and hold the same in trust, to be applied by the said academy in aid of scientific investigations and according to the will of the donors."

The funds under the general management of the academy and their purposes will now be stated in their chronological order.

1. *The A. D. Bache Fund.*—This amounts to over $50,000. It was provided by the will of Alexander Dallas Bache, one of the charter members and the first president of the academy, who was for many years superintendent of the United States Coast Survey. The academy is trustee, and the income is applied to the prosecution of researches in physical and natural sciences.

2. *The Joseph Henry Fund.*—This fund of $40,000 was contributed by a number of friends and admirers "as an expression of the donors' respect and esteem for Professor Joseph Henry's personal virtues, their sense of his life's great devotion to science with its results of important discoveries and of his constant labors to increase and diffuse knowledge and promote the welfare of mankind." The income was to be paid to Professor Henry during his life, and after his death to his wife and daughters, and after the death of the last survivor the fund is to be delivered to the National Academy of Sciences, "the principal to be forever held intact and the income to be from time to time applied by the said National Academy of Sciences in its sole discretion to assist meritorious investigators, especially in the direction of original research." Happily this fund has not yet come into the possession of the academy. It is not necessary to remind this audience that Professor Henry was for years the secretary of the Smithsonian Institution.

3. *The J. C. Watson Fund.*—This amounts to $25,000, and was provided by the will of Professor J. C. Watson, a distinguished member of the academy, who died in 1880. The income "shall be expended by said academy for the promotion of astronomical science." It is also provided "that the academy may, if it shall seem proper, provide for a gold medal of the value of one hundred dollars, from time to time to the person in any country who shall make any astronomical discovery or produce any astronomical work worthy of special reward as contributing to our science." Five medals have thus far been awarded, the recipients being B. A. Gould, Edward Schönfeld, Arthur Auwers, Seth C. Chandler and Sir David Gill.

4. *The Henry Draper Fund.*—In 1883 Mrs. Henry Draper, widow of Henry Draper, late our honored member, presented to the academy a fund of $6,000 for the establishment of a gold medal to be awarded by the academy every two years to the individual in this or any other country who makes the most important discovery in astronomical physics. This fund now amounts to $10,000, as, in accordance with the wish of the donor, the income, above what was required to provide the Draper medals, was for a time allowed to accumulate and was added to the principal until this amounted to $10,000. At present the excess of income is available for purposes of research in the line of astronomical physics. The Draper medallists named in chronological order are S. P. Langley, E. C. Pickering, H. A. Rowland, H. K. Vogel, J. E. Keeler, Sir William Huggins, G. E. Hale and C. G. Abbot.

5. *The J. Lawrence Smith Fund.*—In 1884 Mrs. J. Lawrence Smith, widow of one of our honored members, presented to the academy the sum of $8,000, the object of the gift being to promote the study of meteoric bodies, a branch of science which Dr. Smith had pursued with marked suc-

cess. In accordance with the wishes of the donor it was decided that a gold medal to be given as a reward for original investigations would be most appropriate. Any excess of income above what is necessary for the striking of the medal "shall be used in such manner as shall be selected by the National Academy of Sciences in aid of investigations of meteoric bodies to be made and carried on by a citizen or citizens of the United States of America." Only one J. Lawrence Smith medal has been awarded. The recipient was H. A. Newton, "for the investigation of the orbits of meteors." The income has otherwise been used to aid investigations, especially those of Professor Newton.

6. *The F. A. P. Barnard Medal.*—This was provided for by the will of the late F. A. P. Barnard, one of the incorporators of the academy, and, at the time of his death the president of Columbia College (now Columbia University). The fund is controlled by the trustees of Columbia University. They "shall cause to be struck, with suitable devices, a medal of gold, nine tenths fine, of the bullion value of not less than two hundred dollars, to be styled 'The Barnard Medal for Meritorious Services to Science,' and shall publicly announce that a copy of the same shall be awarded, at the close of every quinquennial period . . . to such person, whether a citizen of the United States or of any other country, as shall, within the five years next preceding, have made such discovery in physical or astronomical science, or such novel application of science to purposes beneficial to the human race, as, in the judgment of the National Academy of Sciences of the United States, shall be esteemed most worthy of such honor." In accordance with these terms the academy has recommended to the trustees of Columbia University the award of the Barnard medal as follows:

In 1895 to Lord Rayleigh and William Ramsay "for their brilliant discovery of argon, a discovery which illustrates so completely the value of exact scientific methods in the investigation of the physical properties of matter."

In 1900 to Wilhelm Conrad Röntgen, "for his discovery of the X-rays."

In 1905 to Henri Becquerel "for his discoveries in the field of radioactivity."

In 1910 to Ernest Rutherford "for meritorious services to science resulting especially from his investigations of the phenomena of radioactive materials."

7. *The Wolcott Gibbs Fund.*—When Wolcott Gibbs, who was one of the incorporators of the academy and at one time its honored president, reached the age of seventy in 1892 a number of friends presented him $2,600 to establish a fund bearing his name, the income to be devoted to aiding in the prosecution of chemical research. Dr. Gibbs presented this fund to the academy, the income to be administered by a board of directors, who "shall have absolute and entire control of the disposition of the income of the fund, employing it in such manner as they may deem for the best interest of chemical science."

8. *The Benjamin Apthorp Gould Fund.*—In 1897 Miss Alice Bache Gould, daughter of the distinguished astronomer, Benjamin Apthorp Gould, one of the incorporators of the academy, who died in 1896, presented to the academy the sum of $20,000 as a memorial of the life work of her father, the income to be used "for the prosecution of researches in astronomy."

9. *The Cyrus B. Comstock Fund.*—This now amounts to something over $10,000 and is to be increased by accumulations of income until it reaches $15,000. A part of the income is to be used to provide "once for every five years a prize in money to the bona fide resident of North America, who,

not less than one year nor more than six years before the awarding of the prize, shall have made in the judgment of the trustees the most important discovery or investigation in electricity or magnetism or radiant energy."

This gift was received in December, 1907, and the first Comstock prize will be awarded at the present meeting.

General Comstock was a distinguished engineer, and a member of the academy. He died in 1910.

10. *The O. C. Marsh Fund.*—Professor Marsh, for twelve years president of the academy, died in 1899. He bequeathed the sum of $10,000 to the academy, "the income to be used and expended by it for promoting original research in the natural sciences." This fund has not yet become available.

11. *The Alexander Agassiz Fund.*—Alexander Agassiz, who was president of the academy from 1901 to 1907, died in 1910, and bequeathed to the academy the sum of $50,000 unconditionally. No decision has yet been reached in regard to the uses to which this fund is to be put.

12. *The Agassiz Medal*, which will be awarded for the first time this year, was provided for by a gift of Sir John Murray.

While this account may have proved tedious to some of you, it seemed necessary for the purpose of giving a correct impression of the work now being carried on. The academy has sacred duties to perform. It will soon devolve upon the younger members to see that these duties are conscientiously performed.

The constitution provides that the academy shall hold one meeting in each year in the city of Washington and another at such place and time as the council may determine. Whatever may be said of the duties of the academy as the scientific adviser of the government and as a custodian of trust funds, it must be acknowledged that it is through the agency of its regular meetings that its influence is mainly exerted. In this as in other matters, it is the subtle, the intangible, the spiritual that tells. Workers in the field of science are supposed by some, perhaps by many, to be incapable of recognizing the force of the intangible, and yet scientific work must inevitably lead to this recognition. It is impossible to weigh and measure the effect of the meetings upon those who take part. But that effect is felt none the less, and it is certain that those who attend are in the long run benefited—some in one way, some in another. This is not a subject that lends itself to profitable discussion. It may not be out of place, however, for one who has been a regular attendant for over thirty years to make public acknowledgment of the debt which he personally owes the academy for the opportunities it has afforded him of associating with and counting among his friends those whose earnest, honest work has been an inspiration to him and to the world. This association has been an inestimable privilege for which he is deeply thankful.

The work of the academy will continue; new and younger members will take up the work. Is it too much to hope that when the centennial anniversary is celebrated some of the members here present may be remembered as we to-day remember with gratitude the founders?

IRA REMSEN

THE RELATION OF SCIENCE TO HIGHER EDUCATION IN AMERICA[1]

THE half century which has elapsed since the founding of this academy has witnessed a radical change in the relations

[1] Address delivered before the National Academy of Sciences on the occasion of the semi-centennial celebration of its foundation.

between science and education. This change is equally marked in the professional training which prepares students for their several callings, and in the general training which prepares them for the duties and enjoyments of citizenship.

Fifty years ago the professional study of science in our universities was confined within very narrow limits—surprisingly narrow to those who see those places as they are to-day. There was no room for science in the schools of theology or of law. Schools of philosophy, in the modern sense of the word, had hardly developed. Even in schools of medicine, where the study of natural science in universities first gained a foothold, there was relatively little of scientific method, as we to-day understand the words, either in the teaching or in the study. There was much more learning of names of things than there now is, and much less learning of reasons of things; much more of tradition and much less of investigation. The anatomy and chemistry of the medical schools of those days were good sciences, as far as they went, but they generally did not go very far. As to the use made of science there is truth in the remark of one of my former colleagues that down to a recent day the three learned professions of theology, law and medicine had not advanced far beyond the old conception of the magic of the tribal medicine man, that the important thing for science to do was to find proper formulas of exorcism with which to banish evil spirits from their several realms of action.

Outside of the universities, a half century ago, things were little or no better. There was a small number of schools of engineering and a still smaller number of schools of chemical technology; but they did not form part of a large scheme of business training for the nation as a whole. Most of the engineers had learned their profession in the field; most of the technologists had learned it in the shop.

All of this has changed during the fifty years of the life of the academy, and changed radically for the better. Our universities have developed scientific study in all their departments, and especially so in their schools of medicine and philosophy. Side by side with these university schools or faculties there have grown up colleges of engineering and technology, sometimes in connection with the university, sometimes outside of it, which lay a scientific foundation for many a calling that only a few years ago was thought to need no scientific foundation at all. The world has found a place for the scientific expert in every line, and is inclined to regard as the best school, not the one that has the most students, not even the one that can give the best general education, but that which in the different lines can train and furnish scientific experts of the highest rank and most varied knowledge.

For civilized nations have at last come to the conclusion that the old supposed antagonism between theory and practise was a misleading conception, and that the habit of drawing a sharp line between the theoretical man and the practical man was a pernicious one.

Fifty years ago a man who had obtained all his knowledge of his business by his own experience was habitually proud of the fact; he was, as the phrase went in those days, a self-made man who spent most of his time in worshipping his creator. He counted it a matter of superiority that he knew nothing except what he had found out himself and taught himself. To-day it is recognized that every practical man can learn much from the theorist; that there is room for the application of scientific principles in every department of life;

that the farmer, the manufacturer or the merchant, no less than the engineer or the physician, must prepare to avail himself of the theory which has been built up by investigators, which has been taught in laboratories and incorporated in books, if he would bring his practise up to the needs of the time.

Of all the conquests of modern science, there is none which, in my judgment, is more remarkable or significant than this conquest of current business opinion. We no longer draw a distinction between learned and unlearned professions. We have recognized that every profession and every trade, in order to be pursued to the best advantage, must be a learned one. None so complex as to be unable to get help from science; none so simple as not to need it. We have shaped our system of technical training accordingly; and we have learned to rate at their true worth the men and the places that can give training as research institutions, side by side with universities which make progress in such training possible.

Equally important, though of a different and perhaps less satisfactory character, has been the change in the scheme of our general education; in the choice of subjects and methods of teaching offered in preparation for the work of citizenship as distinguished from the preparation of each man for his business or calling.

The old course of study in our high schools and colleges consisted chiefly of classics, mathematics and metaphysics, with a little history and a few descriptive courses in natural science. Of scientific training in the modern sense it gave none, except to the unusual man whose mathematical tastes made the study of algebra and analytical geometry a means of scientific education in spite of text-book and instructor and class-room atmosphere, or the still more unusual man who used his grammar and metaphysics as an exercise in closely ordered reasoning. The course, as a whole, was constructed for the student whose interests were in the past rather than in the present and the future. The training which it gave—good, in many respects—was a training in memory, in expression and in accuracy of apprehending language, one's own or another's, rather than in scientific method, as we understand it to-day.

There is on the facade of the main hall of a university which has done much for education in many lines, a representation of philosophy in a dominant central position—old-fashioned metaphysical philosophy—with the different sciences laying tribute at her feet. I suspect that this is not an unfair characterization of the views as to the place of science in education which prevailed among most college faculties a generation or two ago.

Now let me say right here that I do not for a moment overlook the advantages of the old system. It taught the boys to use books and find things out from books, and to expect to do hard work for that purpose instead of to have somebody else make it easy. This was a great merit, and the boys trained under the old system showed this merit. But college faculties were often blind to the particular kind of book learning that was most significant for human progress and which was of most concern to the living world outside.

For at the time when the academy was founded, and in the time since, chemistry and physics and geology and biology were becoming not only matters of importance to the experts in their several callings, as I have indicated, but subjects of real and dominant interest to intelligent men who were not experts, but who cared for knowledge and who cared for current history.

A large section of the world, an increasingly large section of the world, cared more for books that explained the tendencies of the present than for those that embodied the ideals of the past. Perhaps this movement may have gone too far and may have caused people to care too little for the ideals of the past, to overvalue scientific reading as compared with historical or literary reading. I shall not try to discuss whether it did or not. At any rate, a curriculum which was exclusively occupied with classics and philosophy ceased to meet the demands of grown men or the needs of boys, and the course of study in our colleges had to be remodelled accordingly. Each decade of the last fifty years has witnessed a gradual crowding out of classics from our older schools and colleges by subjects of new and more present interest, and a growth of new schools and colleges of a different kind, where science in varying forms is made the chief subject of attention and other matters relegated more or less to the background.

Now this increasing interest in science is a matter about which we all, members of the academy and guests of the academy, scientific men and literary men, may rejoice heartily. But how far the things that are called science always deserve the name of science, or how far the teaching of such subjects by present methods always deserves the name of education, is quite another question. Every school superintendent likes to stimulate the attention of his pupils by giving them the opportunity to see amusing phenomena with their own eyes, and if possible set them in motion with their own hands. Under some circumstances this may be the best kind of scientific training; under other circumstances it may be no training at all.

Nature study—to quote a phrase which is popular among educators of the present time—is good if it is made the basis for teaching scientific methods, and bad if it is simply made a means of momentary amusement. Unfortunately, a large part of our school committees and school teachers think that the subject makes the science. They may not go as far as the author of "Murray's Handbook to Spain," who says that the mountains of that country, to quote his own words, "abound in botany and zoology." But they are apt to assume that the picking to pieces of flowers is in itself botany, and that hearing a carbon disulphide mixture make a loud explosion marks progress in chemistry, and to act accordingly. A short time ago a school superintendent in one of our more newly developed parts of the country said he had to make a change because it was so easy to find thoroughly competent teachers of physics, but that so few of them ever knew any algebra.

Fifty years ago the members of the National Academy of Sciences who held seats in college faculties were occupied in protecting science against its enemies. I am not sure but what to-day their chief duty lies in protecting it against its friends. When the National Educational Association says that high schools should be allowed to omit the study of algebra and geometry and that the colleges should be compelled to accept for admission an equivalent amount of "science"—God save the mark!—it is time for the true friends of science to call a halt.

For the importance of scientific training to the student in our high schools and colleges is not due primarily, or in large measure, to the facts of physics or biology that he learns in the school. It is due to the training in certain habits of observation and deduction, in certain methods of hypothesis and verification, which he can get more effectively by a good course in science

than by one predominantly devoted to languages, where the scientific training is merely incidental. That the facts of physics or biology are more interesting to the student and to the world than those of Latin and Greek and have more obvious bearing on everyday life is a help to the teacher in securing the voluntary cooperation of the pupil; but it is far from being the fundamental reason why the subjects themselves are educationally valuable. It is not the subject that makes the course scientific; it is the method.

You have been good enough, Mr. President, to refer to my father's connection with the academy, and I for my part am glad to take the opportunity to say that he regarded his election to membership in this body as the greatest honor he ever received. I feel sure, therefore, that I shall be pardoned if I illustrate the point I have just made by reference to my father's teaching.

Fifty years ago the one course in the academic department of Yale College where modern science was really taught, was the course in freshman Greek. For my father, though he had the highest enjoyment of classical literature, was by training and temperament a philologist; and he taught the freshmen who came under him to take Greek verbs to pieces and compare and observe their parts and put them together again, and see what principles were involved in the analysis and synthesis, exactly as the botanist might have done with his plants or the chemist with his elements.

In those days chemistry and physics were taught in Yale College, as distinct from the Sheffield Scientific School, solely by text-books and lectures. Philology was taught by the laboratory method; and for that reason the freshman Greek course was a course in modern science and meant that to the pupils. The courses in chemistry and physics widened the boy's knowledge of facts and doubtless encouraged many of them to get scientific training for themselves afterward; but the course in freshman Greek was a course in science, because the boys learned to do the things, both easy and hard, which are the heritage of the man of science.

Science is not a department of life which may be partitioned off from other parts; it is not the knowledge of certain kinds of facts and the observation of certain kinds of interest, as distinct from other facts and other interests; it is a way of looking at life and dealing with life; a way of finding out facts of every kind and dealing with interests as varied as the world itself,

Where each for the joy of the working, and each
in his separate star,
Shall draw the thing as he sees it, for the God of
things as they are.

ARTHUR T. HADLEY
YALE UNIVERSITY

SPEECHES AT THE ANNIVERSARY DINNER OF THE NATIONAL ACADEMY OF SCIENCES

SPEECH OF THE RIGHT HONORABLE JAMES BRYCE

Doctor Woodward, President Remsen and gentlemen: I am very much touched by the kind words in which my old friend, Dr. Woodward, has introduced me to you, and I am more than grateful to you for the way in which you are kind enough to receive me. It does make one happy to be so received and to be assured that one has not lived in this country six years without having acquired some friendliness on the part of its people.

But, apart from that, gentlemen, I stand before you this evening as a rather unhappy man, because it is the last evening on which I am likely to have the privilege —at any rate, in an official capacity—of

meeting an audience of American men of science.

One of the most delightful parts of my sojourn in Washington has been my intercourse with your men of science. There is not any city in America—I doubt if there be any city in Europe—where so many men of eminence in science are assembled as live in Washington, and the gatherings which you have here, when the men of science from the whole of your wide country come together, have been among the most delightful experiences that I or any Briton has had in this country. I have had it also in Philadelphia and in New York, and I have had the pleasure of making the acquaintance of your men of science in many journeys all over the country; but this, after all, is the focus to which is gathered most of the scientific lights and leaders of the United States at stated intervals when you come together here.

And I can assure you, gentlemen, there is nothing I shall look back to with more pleasure, in so much of life as remains to me, as to the friendships I had formed with your scientific men and the inspiration I have derived from the ardor and energy with which they pursue the studies to which we are all so much debtors.

Dr. Woodward has suggested that I should say something about foreign academies, but my knowledge about foreign academies is, really, practically confined to my own country, for, whenever I have traveled abroad, it has rather been among the historians than among the men of science that my work has lain.

However, I should in any case feel a little doubtful about venturing to talk about scientific academies, knowing that, whatever else "science" means, Mr. Vice-President, it is supposed to mean knowledge; and if a man feels that he does not know a thing, scientific people are the last to whom he should address his remarks.

I received at Oxford my literary education, and I remember "education" being defined by a very eminent professor there, who said: "What our Oxford education does is to teach our men to write plausibly about subjects they do not understand"—an art which we were in the habit of exemplifying by immediately beginning to write for the journals and reviewing books—whose authors knew infinitely more about their subject than we did—in a very superior manner, an experience which, however, is not confined to England.

The vice-president said, gentlemen, that he regarded men of science with fear and veneration. I share those feelings. I have veneration for the lofty and disinterested spirit which you bring to your work. I have fear for the enormous power you exercise.

You are really the rulers of the world. It is in your hands that lies control of the forces of activity; it is you who are going to make the history of the future, because all commerce and all industry is to-day, far more than ever, the child and product of science; and it is you who make these discoveries upon which, when they are applied by industry, the wealth and prosperity of the world depend. It is in your hands that the future lies, far more than in those of military men or politicians.

But I have another feeling besides fear and veneration. It is that of envy. I envy you your happy lives. Compare your lives with the lives of any other class. If the vice-president will permit me, I think the life of a man of science is a great deal happier than the life of a politician or the life of a statesman, who, as we know, is many pegs above the politician, because the politician is occupied, as the vice-president has said, in endeavoring to promote the

interests of his party and not the interests of his country; and I discovered, during my experience in the House of Commons in England, that a legislative assembly is the worst place in the world for the discovery of abstract truth.

Or, take the case of the lawyer. So far from seeking to discover the truth, in one half of the cases which he conducts, he is endeavoring to obscure the truth. Or, even take the case of the artist or the literary man, who has a subject to work upon, delightful and interesting in itself, in evoking from the stone, or by colors, shapes or forms of beauty, which will far outlive him; but these forms of beauty will profit him very little if they do not commend themselves to the popular tastes, and he is constantly under the temptation of doing something less good than he wishes, in order to meet the tastes of his patrons.

It is the man of science who has the really happy life. He is engaged in the discovery of the truth, and nothing but truth. The applause of the multitude is nothing to him. He is working for a mistress more exalted than any popular assembly or any multitude that we can conceive of. He is working for Truth herself, and for the future. He is consecrating his efforts to the highest task that God can lay before man, and in that he needs nothing but the sense of what he is adding to the sum of human knowledge, and he has the incomparable pleasure of feeling that the more he knows, the more the immense ocean of knowledge stretches itself out before him. The further he outlines any path into the untrodden solitudes of ignorance, and the more he blazes those paths and makes them paths of knowledge, the more he sees other paths branch out before him, leading further and further away into the realms which others after him will traverse.

In these things, friends, there are elements of pleasure and delight, elements also of independence, which I think no other profession can equal. I was tempted to add one other charm which your life has. It is the charm of poverty. I have sometimes felt inclined to wish, Mr. Vice-President, that Congress was a little more liberal to the scientific men who are working for Uncle Sam. But perhaps they are to be congratulated on being free from those temptations which beset wealth. Poverty, like other things, is good if you have not too much of it, because it saves one from the temptation of forgetting the end to the means, the temptation to which most of us, and, above all, those who are in search of wealth, succumb. You keep the end always before you, and you proportion your life to that end.

Still, I think you might, with advantage, not only to you, but, what is far more important, to the whole country—and it ought to be possible in a wealthy country like this—provide upon a more ample scale for those who follow science, and give science a more exalted position, by freeing the scientific man from any thought of domestic anxiety.

You enjoy in this country—I speak here of particular branches of science—some things which we, in England, greatly envy. Think of what the geologist or the botanist has before him here! We have been working for one hundred and fifty years upon the geology, and for more than that upon the botany, of our little island; but here you have the whole continent open to you, and any man of science on these subjects can make a reputation for himself by new work in new fields, such as is impossible for us in outgrown Europe.

Gentlemen, one word I venture to say about the scientific bodies of the continent of Europe. We have, in the Royal Society, the oldest of those bodies, and one which, I think, has always maintained the level

which it took in the great days when Isaac Newton was one of its members; and now there has sprung up all over Europe a host of other bodies pursuing science and following it into those infinite ramifications which modern science has discovered. Everywhere there you are welcome. One of the most delightful things of science is that it knows no divisions or allegiance to nationality. It is a republic in which there is no passport to greatness, except service and genius, and it is a republic of which every one is a citizen, and where every one has equal rights in every part of the world.

That has always been our tradition in England and in our Royal Society; and I know it is your tradition here, and I know what hearty welcomes you have always given to our men of science when they have come over here, and how refreshed and invigorated in spirit they have been when they have gone back to their own country.

Gentlemen, I can wish nothing better for any of us than that these comings and goings will be frequent, and I can assure you that it will always be a pleasure to the scientific men of England and Scotland to welcome you to their societies and to all their gatherings and universities. I hope that, more and more, these meetings will take place, and I can assure you that all you have achieved and all that you are achieving in so many ways on so many different lines for the advancement of knowledge, for the extension of human power that comes through knowledge, is followed with gratitude and admiration by the scientific men of Great Britain.

SPEECH OF DR. S. WEIR MITCHELL

Mr. President, Mr. Vice-President, my brothers of the Academy: I am, I presume, the victim of the after-dinner hour, as usual, and am well aware of the treachery of the tongue, and much prefer the loyalty of the pen. I have, therefore, deliberately put on paper that which I want to say to you to-night, feeling that it will be much more probable that I shall interest you than if I trusted to my unassisted words.

I am, I presume, indebted to the liberal forbearance of time for the honor of being asked to speak to you this evening. It does not find me in the careless mood of after-dinner gaiety, nor is it possible to escape altogether from personal remembrances, which elsewhere than at this friendly board might entitle me to be relegated to what Disraeli called the "fatal time of anecdotage."

My diploma is dated August 25, 1865, three years after our foundation. It is signed by Dallas, Bache, Wolcott Gibbs and Louis Agassiz. Since then, one hundred and thirty-six of our fellowship have come and died, with an average duration of academic life of more than eighteen and a half years—very many with far less. This makes clear that in those earlier years our additions were of men older than those we elect now.

At present the liberal endowment of research opens the way to distinction for younger men, unembarrassed by the time-killing need to preach science as well as to practise it.

Between the mere words of our record—*elected—deceased*—you, who are familiar with our history, may read much that is written clear on the roll of scientific achievement.

Here are they to whom, from the depths of space, were whispered in the night watches its long hidden secrets. There, too, are those who, in the silence of the laboratory, rejoiced in the fertile marriage of the elements, or they who, like confessors, heard from dead bones or rock or flower

the immeasurable history of the silent ages of earth.

One might linger long over many of these lives whose interests were so remote from thought of the commercial gains their unselfish work made possible. But there are other compensations, and there are men here to-day who are aware that there is no earthly pleasure more supreme than to find disclosed some secret of nature unknown before, save to Him who set in motion the complex mechanism of the universe.

The later life of the merchant and the lawyer loses vitality of normal interest as age comes on; not so the man of science. The eternal love of nature is his—a mistress of unfading charm.

I remember once that, at my table, some one asked that ever happy naturalist, Joseph Leidy, if he were never tired of life. "Tired!" he said, "Not so long as there is an undescribed intestinal worm, or the riddle of a fossil bone, or a rhizopod new to me."

My first remembrance of an Academy meeting is of 1866. We met in a Smithsonian room. There were not more than fifteen present. Professor Henry was in the chair.

I remember Benjamin Peirce, Wolcott Gibbs and Gould. Agassiz sat on one side of me, and on the other Coffin. It was all very informal. The first scientific paper was by Professor Peirce, who for twenty minutes occupied us with algebraic formulas and mathematical figures, until he turned and said that he had got out of the region of material illustration, and so led us on through the endless equations in which I had lost myself at the very outset.

Agassiz turned to me at the close and said, "Were you able to follow him?" I said, "No; I can not do a sum in the Rule of Three without trying it over two or three times." Upon which the delighted naturalist added, "Ni moi non plus." Professor Coffin remarked, "He was traveling with Seven-league Boots over a country across which I should have to crawl."

Some of this was quite audible to Peirce, who said that the only thing required was more careful attention than men were willing to give to the great science of mathematics, and that our incapacity to understand and follow him was due to our want of proper education.

He was succeeded by Agassiz, who made the first announcement of his discovery of the additional heart found in the tail of the young of the salmon.

I recall very little else about these delightful people, except that they—all of them—were not only in the peerage of science, but also companions as socially interesting as they were learned.

Perhaps the most pleasant remembrance I have of all is of Louis Agassiz and Joseph Henry. The former was good enough to take a great interest in some of the animal physiology with which I occupied the rare leisure of a hard-worked young doctor. His enthusiasms were shown in odd ways at times.

On one occasion he was staying with Professor Frazier, and dismissed me on the front step one slippery day in February. I had got some distance from him when he came after me in haste, sliding over the pavement. "I did want to say to you one thing. Are you acquainted with the opossum?" I said, rather confused, "No." He said, "I advise you to acquire a physiological friendship with the opossum. He is a mine of physiological wealth."

Jeffries Wyman, who was elected in 1872 and died in 1874, was another who held a place in my most honoring regard. He resembled Joseph Leidy in that splendid magnanimity and unselfishness which con-

trasted so agreeably with the disgusting quarrels, happily rare, which sometimes arose among men of science.

As you have made me speak here, I am forced to say something of myself, and hence this anecdote of Wyman. I had written him word of the discovery I had made of the chiasm of the superior laryngeal nerves in the chelonia—that is to say, turtles—and it greatly excited him, especially my prediction that it would be found in serpents and probably in birds. A year afterwards he sent me a large bundle of illustrations and descriptions of what he had found in other classes than the turtle, and insisted that I should use them in the second paper I was about to print, stating that they would not have been discovered had it not been for my predictive aid. Of course, I declined this help; but it was characteristic of the noblest form of the scientific mind.

You will, I trust, pardon me if I close this long talk with a few too personal words about the much loved first director of the Smithsonian Institution, first of the men who sacrificed to that Institution a scientific career. When a boy about fifteen years old, I was sent by my father to Professor Henry at Princeton with some glass apparatus, which could not otherwise be sent without danger of breakage.

He met me at the station, took me to the house, and spent a part of the next morning endeavoring to explain to my bewildered youth the experiments he was making in the transmission of electric signals. I was overcome by the unwonted attention paid to a boy of my age, and expressed myself so warmly that he laughed as he bade me good bye, saying: "Well, life sometimes gives one a chance to return little favors, and perhaps some day you will have an opportunity to oblige me."

Long years passed by, and some time in the beginning of 1878 Professor Henry asked me to come to Washington and advise him. After a thorough examination of his case, he asked me plainly if he was mortally ill. I said, "Yes." Then he asked how long he had to live, but I could not set a date. He said, "Six months?" Hardly, I thought. He died in May of that year.

As I arose to go away, his carriage waiting, he said: "I have yet to discharge my material obligation. How much am I in debt to you?" I replied, "You are not in debt. There are no debts for the Dean of American Science."

He was much overcome, and said: "I have always found the world full of kindness to me, and now here it is again." I could only say: "You do not remember, sir, that once you said to me, a boy, when you had been very kindly attentive to me and I tried to express my obligation, that perhaps a time might come when I could oblige you. If this obliges you, my time has come." And so we parted.

I may add what some of you already know, that Alexander Agassiz wrote me he had intended to return home early from Europe, in order to give a dinner such as we are having here to-night. He died on the way over, and his letter reached me after his death—strangely enough, the fourth letter I have received from men who were not alive at the time their words reached me.

My talk has been of men dead long ago, but I should be ungrateful to the longest friendship of my life if I did not pause to remind you of our latest loss in John Shaw Billings. He was a man of too many competencies to allow of even allusive comment here. Few men have been better loved or had so enviable a capacity to convert mere acquaintance into friendship.

It is difficult for a man as old as I am to talk in the gay after-dinner mood, and

if I have been too somber and too personal, I trust that I may not have been guilty of the social crime of having been uninteresting.

SCIENTIFIC NOTES AND NEWS

On the occasion of the installation of the Duke of Northumberland as chancellor of Durham University honorary degrees were conferred on the following men of science: D.C.L., Lord Rayleigh; D.Sc., Sir Archibald Geikie, K.C.B., Sir William Ramsay, K.C.B., Sir T. C. Allbutt, K.C.B., Sir J. A. Ewing. K. C. B., Sir William Crookes, O.M., Sir J. J. Thomson, O.M., and Professor E. B. Poulton.

The Linnean Society, London, has awarded its Linnean medal to Professor Adolf Engler, of Berlin.

The French Academy of Moral and Political Science has elected M. Pierre Janet, professor of experimental psychology at the Collège de France, to the chair left vacant by the death of M. Fouillée.

When the Lobachewski Prize was recently awarded to Professor Schur, of Strasburg, the committee also awarded an honorable mention to Professor Julian L. Coolidge, of Harvard University, for his book on "Non-Euclidean Geometry," Oxford, 1909.

The annual meeting of the Iron and Steel Institute was held in London on May 1 and 2, when the Bessemer gold medal for 1913 was presented to Mr. Adolphe Greiner by the president, Mr. Arthur Cooper. The Andrew Carnegie gold medal for 1912 was presented to Dr. J. Newton Friend.

The Manchester Literary and Philosophical Society has nominated Sir Thomas H. Holland, F.R.S., to represent it at the twelfth International Congress of Geology, to be held in Toronto in August next.

Dr. James W. Glover, professor of mathematics and insurance at the University of Michigan, has been appointed expert special agent of the Bureau of the Census to supervise the preparation of a special volume on vital statistics. Extensive mortality tables are to be prepared, based on the population and vital statistics of the United States. Dr. Glover has also been appointed collaborator to the Office of Public Roads in the Department of Agriculture to assist in the preparation of several bulletins on the various methods of issuing and financing public highway bonds.

Professor Amos S. Hershey, head of the department of political science at Indiana University, and Dean Walter Williams, dean of the school of jurisprudence at the University of Missouri, have been appointed fellows of the Kahn Foundation for the coming year, and both will begin a one-year tour around the world within the month. The fellowships carry with them a stipend of $3,000 for each appointee and in addition there is an allowance to each of $300 for purchases.

Professor Herbert R. Moody, of the College of the City of New York, is in residence for the summer term at Oxford University, where he is associated with Mr. T. V. Barker, of the department of mineralogy at the University Museum. Professor Moody is engaged in learning from Mr. Barker the details, so far as developed, of the von Federon method of Crystallo-Analysis. Mr. Barker learned Russian last year in order to work with von Federon in St. Petersburg. The method is not yet made public.

At the annual general meeting of the Marine Biological Association of the United Kingdom, held in the rooms of the Royal Society on April 30, the following officers and members of council were elected for the year: *President*, Sir Ray Lankester; *Chairman of Council*, Dr. A. E. Shipley; *Hon. Treasurer*, Major J. A. Travers; *Members of Council*, E. T. Browne, L. W. Bryne, Dr. W. T. Calman, Professor H. J. Fleure. Professor F. W. Gamble, Sir Eustace Gurney, Commander Campbell Hepworth, Professor J. P. Hill, E. W. L. Holt, Professor E. W. MacBride, H. G. Maurice, Dr. E. Schuster, G. W. Smith, Professor D'Arcy W. Thompson; *Hon. Secretary*, Dr. E. J. Allen. The following governors are also members of council: G. P. Bidder, the

Earl of Portsmouth, Sir Richard Martin, the Hon. N. C. Rothschild, Professor G. C. Bourne, Dr. A. E. Shipley, Professor W. A. Herdman.

As has already been announced, the committee of the Lister Memorial Fund proposes that the memorial should be of a threefold character: (1) A simple marble medallion bearing a sculptured portrait of Lord Lister to be placed in Westminster Abbey among the monuments of the nation's illustrious dead; (2) a larger and more conspicuous monument to be erected in some public place in London, the city wherein he lived and worked; (3) if funds sufficient shall be obtained, the founding of an International Memorial Fund from which either grants in aid of researches bearing on surgery or rewards in recognition of important contributions to surgical science shall be made, irrespective of nationality. The *British Medical Journal* says that the sum already subscribed or promised is perhaps sufficient for the completion of the first two parts of the proposed memorial, which are of local character, but for the third, or international part of the memorial, an international appeal is now being made, and a letter has been addressed by the secretary, Sir John Rose Bradford, to the principal universities and medical societies on the Continent of Europe and in the United States. A similar letter is being sent to the corresponding institutions in the British dominions and colonies. Among the subscriptions received for the international fund are the following: Academy of Sciences, Paris, 500 francs; University of Paris, 500 francs; Medical Faculty of the University of Montpellier, 250 francs; the Karolinska Medico-Kirurgiska Institutet, Stockholm, £5. Vladimir Kowalevsky, president of the Technological Society of Russia, has made a donation of £5 "in memory of one of the greatest benefactors of the human race." The universities of Michigan, Yale, Harvard and Leland Stanford (California) have already undertaken to promote the memorial, and the College of Physicians, of Philadelphia, has made a special appeal to its fellows. In addition, Dr. Keen, of Philadelphia, is making a somewhat wider appeal. The University of Toronto has appointed a special committee to promote the fund. The honorary treasurers of the fund are Lord Rothschild and Sir W. Watson Cheyne. The offices of the fund are at the house of the Royal Society, Burlington House, Piccadilly, London, W., and subscriptions, made payable to the fund, may be sent to the treasurers there.

CONGRESS has furnished the Bureau of Entomology with funds to be used in the eradication of the tick which transmits spotted fever in the Bitter Root Valley in Montana. Dr. T. Ricketts demonstrated that the disease is transmitted only by the tick *Dermacentor venustus*. Investigations conducted by the Bureau of Entomology in cooperation with the Montana Agricultural College have shown that a comparatively simple and inexpensive plan of eradication of the tick may be put into operation. Cooperation has been arranged with the Montana State Board of Entomology, recently created at the session of the Montana Legislature, whose duty it is to "study the dissemination by insects of diseases among persons and animals, said investigation having for its purpose the eradication and prevention of such diseases." The board is further required to take steps to eradicate and prevent the spread of diseases that may be transmitted by insects and an appropriation of five thousand dollars a year for the next biennium is made. The immediate object in passing the law was to provide for the eradication of the Rocky Mountain spotted fever tick. The membership of the board is *ex officio* and is made up of the secretary of the State Board of Health, chairman; the state entomologist, secretary; and the state veterinarian.

AT the recent meeting of the National Association for the Study and Prevention of Tuberculosis in Washington the following resolutions were adopted: "WHEREAS, Widespread publicity has been given to the claims of an alleged cure for tuberculosis. *Resolved*, That there is no information before the National Association for the Study and Prevention of

Tuberculosis to justify the belief that any specific cure for tuberculosis has been discovered which deserves the confidence of the medical profession or the people, and, *Resolved,* That it is the duty of the public to continue unabated all the present well-tried agencies for the treatment and prevention of tuberculosis."

THE trans-Saharan party of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington arrived at Timbuctoo on May 16. Since leaving Biskra, Algeria, on October 29, 1912, the party has secured complete magnetic observations at about seventy stations.

MR. CAWTHRON, of Nelson, New Zealand, has offered to give $60,000 for a solar physics observatory.

THE Historical Medical Museum, organized by Mr. Henry S. Wellcome, which is to be opened in London towards the end of June next, will include, as we learn from *Nature,* among the exhibits in the science section a large collection of the original apparatus used by Galvani in making his first experiments in galvanism in the eighteenth century. Other exhibits will be a collection of votive offerings for health, ancient microscopes and optical instruments, amulets and charms connected with English folk medicine, early medical medals and coins from the Græco-Roman period, and early manuscripts and medical books.

THIS week a joint meeting of the Institution of Electrical Engineers of London and the Société Internationale des Electriciens is to be held in Paris.

THE Index of Authors and of Subjects in the first thirty volumes of the *American Journal of Physiology* is ready. The index contains about 160 pages and is bound in paper. The edition is limited. Such indexes are valuable to scholars, even to those who do not possess a file of the *Journal.*

UNIVERSITY OF SOUTHERN CALIFORNIA students have completed the organization of the first Pacific Coast chapter of the Agassiz Association, the national organization of nature students, choosing Burbank Chapter for their distinctive name. Mr. Luther Burbank will probably be one of the speakers to address the chapter this year. The chapter programs include bi-weekly field trips to points of interest around Los Angeles, frequent social gatherings at the homes of members and monthly lectures by outside naturalists.

THE following lectures have been given during the year at the University of Iowa under the auspices of the department of physics:

"The Ether," Professor K. E. Guthe, of the University of Michigan.

"The Measurement of the Charge of Thermions," Dr. J. C. Pomeroy, of Iowa State College.

Some Physical Aspects of a Comet's Tail," Professor D. W. Morehouse, of Drake University.

"The Elementary Electric Charge" and "An Extension of the Brownian Movement Theory," Professor R. A. Millikan, of the University of Chicago.

"Applications of Least Squares in Physical Research," Professor Leroy D. Weld, of Coe College.

"Carriers of Positive and Negative Electricity," "Properties of the Wehnelt Cathode Rays" and "The Beaded Character of the Cathode Ray Line," Professor C. T. Knipp, of the University of Illinois.

THE subject selected for the Adams prize in 1914 is "The Phenomena of the Disturbed Motion of Fluids, including the Resistances encountered by Bodies moving through them." A theoretical rediscussion of the problem of fluid resistance may be undertaken, either in general or in simple cases, in the light of the experimental knowledge regarding the resistances and the nature of the broken motion of the fluid which is becoming available in the publications of the aeronautical laboratories of various countries. Information has been accumulating regarding the nature and mode of travel of meteorological atmospheric disturbances, such as cyclonic movements and line squalls, the propagation of minute waves of barometric pressure, and the nature of the lower boundary of the upper calm region of the air. A dynamical discussion of these topics, or of simpler problems in illustration of them, might be undertaken. The prize is open to the competition of all persons who

have at any time been admitted to a degree in the University of Cambridge. The value of the prize is about £220. The essays must be sent to the vice-chancellor on or before the last day of December, 1914.

UNIVERSITY AND EDUCATIONAL NEWS

IN memory of a husband who for years had suffered from a malady that eluded medical skill, Mrs. George William Hooper, of San Francisco, has transferred to the University of California $1,000,000 for the establishment of an institute of medical research. The foundation is to be controlled by an advisory board of seven members constituted as follows: The president of the Carnegie Foundation, who is now Dr. Pritchett; the professor of pathology at the Johns Hopkins University, the director of the Rockefeller Institute for Medical Research, the president of the University of California, the dean of the Medical School of the University of California, E. D. Connolly, representing Mrs. Hooper, and a seventh member to be chosen by the western members of the advisory board.

THE late Dr. Louis A. Duhring, formerly professor in the University of Pennsylvania, in his will disposes of an estate valued at about $500,000. His notes on medical cases are given to the university, and the will creates a trust fund of $25,000, the income of which is to be used for the benefit of the department of cutaneous medicine. The will gives the University of Pennsylvania Hospital $50,000 for the establishment of free beds in which cutaneous, cancerous and allied diseases shall be treated. After making a number of private bequests, the testator directs that the residue of the estate be given to the trustees of the University of Pennsylvania, and that it be applied to the treatment of cutaneous diseases and their study.

MR. STEVENS HECKSHER has given $10,000 to the University of Pennsylvania to establish a fellowship in medical research.

FRIENDS of Professor William Otis Crosby have presented to Columbia University the sum of $1,800 for the establishment of a collection of lantern slides to be known as the "William Otis Crosby Collection of Geological Lantern Slides."

THE trustees of the University of Illinois have voted that for students entering in September, 1913, the requirements for admission to the College of Medicine (formerly the College of Physicians and Surgeons of Chicago) be raised to at least one year of collegiate work in addition to fifteen units of common and high school work, and that for students entering September, 1914, the minimum requirement further be increased to two years of collegiate work in some college or university of recognized standing.

MR. C. L. DAKE has been appointed assistant professor of geology and mineralogy in the Missouri School of Mines. He was instructor in geology at the University of Wisconsin during 1911–12, and during 1912–13 at Williams College.

DR. LEO F. GUTTMANN, formerly head of the division of physical chemistry at the College of the City of New York, and for the last four years assistant professor of physical and industrial chemistry at Queen's University, Kingston, has been appointed associate professor of chemical engineering.

DR. GEORGE SHANNON FORBES, instructor in Harvard University, has been promoted to be assistant professor of chemistry.

PROFESSOR OSWALD KÜLPE succeeds Professor Th. Lipps as professor of philosophy at Munich.

DISCUSSION AND CORRESPONDENCE

THE LAWS OF NOMENCLATURE IN PALEONTOLOGY

TO THE EDITOR OF SCIENCE: A number of recent letters in SCIENCE on the subject of nomenclature may serve as an excuse to present to those interested a few of the special difficulties that beset the vertebrate paleontologist in questions of nomenclature.

The writer holds no brief for the law of priority. Names, scientific or popular, are, after all, but words designed to convey a certain concept, and the fixity and uniformity of that concept might quite well have been—or be—secured by an official dictionary which

should do for scientific names what the standard dictionaries do for words in general, namely, embody and fix as accurately as possible the current usage and significance of the word. That is what the proposal for an official list of scientific names amounts to, if carried out to the limit of its apparent trend. It would no doubt substitute references to types or descriptions for the dictionary definitions of meanings; but that is unessential.

The real objections to such a plan, as it seems to me, are (1) that the law of priority is so thoroughly imbedded in the mind of most systematists, and regarded so much as a moral or legal issue, a matter of justice to the first describer or of correct interpretation of certain statutory rules, rather than as a matter of convenience, that the authorities in systematic work would not abide by dictionary usage in the matter. (2) That any extensive list that could be prepared would certainly contain many names that were open to exception because the references or types so standardized were inadequate, or the current usage not approximately universal.

The first objection is illustrated by Dr. Dall's contemptuous rejection of the proposition that proposals approved by the majority of the committee on nomenclature should be submitted for endorsement or rejection to the body of the Zoological Congress. He will not abide by majority rule in the matter, even a majority of a committee of experts; and for a majority decision of "five dollar subscribers" he has no respect at all. The second objection is one that would be of special weight in any attempt to standardize the nomenclature of vertebrate paleontology.

But it has been said: If the systematists will not conform, let them go their way, and the rest of us go ours. To such a remark one can only say: Try to put such a scheme in the form of a definite program and see where it would land you. The scientific body is an organic whole interacting in all its parts, and Æsop's fable of the belly and the members is very much apropos. Altogether it would seem that the present methods and usages, annoying and exasperating as they often are to the teacher and morphologist, wasteful and time-consuming to the systematist, can not be modified to any material extent without causing further confusion.

The systematists are in the habit of assuring us that this confusion is only temporary; that when the laws of priority have been correctly and exactly applied to all species and genera, a stable and unchanging nomenclature will result; there will be no further changes. So far as vertebrate paleontology is concerned, I am certain that this optimism is unjustified and I doubt whether it is so in other branches of zoology. After the nomenclature has been revised it will be stable until somebody revises it again, just so long and no longer. Every new reviser, having new evidence at hand, or stressing differently the data already considered, is liable to interpret the case differently, and each difference in the interpretation of some obscure or minor point is liable to result in a whole series of alterations of well-known and important names. Only by forbidding the re-investigation of cases already authoritatively considered can changes be prevented. And that is just what Professor Ward's committee wants to do, and Dr. Dall makes it clear that systematists of the highest standing would not accept any such ruling. The plain fact of the case is that scientific nomenclature has come to a pass where the common name of a species is the only name with any permanency or prospects of permanency, and it is necessary to use it or to provide one if there is none already, in order that one's readers—aye, even other systematists—shall know what animal is under discussion. A century ago scientific writers wrote descriptions in dog-latin and then explained in good English or other modern languages what they were talking about. To-day they write descriptions under a scientific name dug out of some old forgotten treatise, and provide it with a wealth of learned synonymy, and then explain by means of the "dear old familiar name of the text-books" or the still dearer vernacular name, what animal it is that they are describing. Fashions change; not always in the way of progress.

In his last letter, Dr. Dall suggests a method of reconciling the differences between teachers and systematists by allowing the use of the "text-book name" with the status of a vernacular name, and a plus sign before it. I adopted a somewhat similar compromise some years ago, in a check list of American Tertiary mammals, only I put the commonly accepted name first, and the "correct" name afterwards, enclosed in brackets and with an equality sign before it. Now doubtless there are specific differences between this and Dr. Dall's discovery, but I claim that the *genus* is the same, and that therefore, *I* am entitled according to the law of priority of which he is so able a defender, to that statue which he expects to receive from the grateful teachers. Especially as I am sure my modification would be more acceptable to them, and while I feel less certain of his cordial approval, I don't see what legitimate exception he can take to it.

The vertebrate paleontologist is in some respects almost free from the difficulties in interpreting and applying the laws of nomenclature that beset his zoological brother. The literature with which he deals is mostly of recent date, and reasonably cognizant of the laws and decencies of nomenclature. There are only a few cases in vertebrate paleontology where there is any particular difficulty in fixing the type of a genus, the date of its publication or the species intended to be included under it.

His serious problem lies in the nomenclature of species, the identification of type specimens, and especially to know what to do with the fragmentary and almost indeterminate types of most of the older and many of the newer species, in relation to more complete specimens subsequently obtained. A quotation from Professor Marsh may be apropos.

> A single tooth or vertebra may be the first specimen brought to light in a new region and thus become the sole representative of a supposed new form. The next explorer may find more perfect fragments of the same or similar forms, and add new names to the category. A third investigator with better opportunities and more knowledge may perhaps secure entire skulls or even skeletons from the same horizon, and thus lay a sure foundation for a knowledge of the fauna.[1]

The wording is curiously suggestive of Professor Marsh's probable opinion of the activities of Leidy, Cope and himself in the field of American paleontology; but it is at all events a sufficiently accurate description of the general progress of the science. The earliest finds in any newly explored formation are generally fragments. They are new, they are of scientific importance, they are distinct from forms hitherto known, they ought to be described and figured, and they ought to be named as a matter of convenience in scientific discussion. But they will undoubtedly make trouble later for the systematist. The "next explorer" must either "add new names to the category" or identify one or more of his fragments with the first described type. And if his material comes from a different locality such identifications may cause serious errors in stratigraphic correlation. The third investigator may ignore the earlier types as too incomplete for identification, or he may arbitrarily identify them with such of the species secured by him as suits his convenience. Either method will subject him to criticism and be liable to mar the scientific results of his investigations.

It is a covenant universally accepted that a new species is not to be described unless it can be shown or inferred to be different from all previously described species. But here it simply can not be applied. The third investigator may have at hand skulls and skeletons of a dozen species all clearly distinct from one another, yet any one of them may be cospecific with the tooth or fragment on which an earlier species was founded, and it is often absolutely impossible to find in the type any characters that are really valid evidence for referring to it one rather than another of these later discovered species.

The difficulty in treating of these more or less indeterminate species recurs again and again in the literature of vertebrate paleontology, causing endless confusion and error when arbitrary identifications are subsequently

[1] "The Value of Type Specimens," *Am. Jour. Sci.*, 1898, Vol. VI., p. 402.

found erroneous and infinite recrimination and heartburning when the work of earlier authors is set aside or ignored. These troubles we shall have with us always; but perhaps their amount might be reduced if an intermediate course were adopted.

The earlier type may be a specimen showing unmistakable ordinal, family or generic characters, but not adequate as a specific type. Let it stand so. Do not set it aside as "indeterminate," but specify the extent to which it *is* determinable. It can remain in the literature and be included if desirable in faunal lists, but additional material should not be referred to it unless the new specimens be topotypes, *i. e.*, from the same locality and the same geological level, so far as these are recorded or can be safely inferred from the literature, unpublished notes or labels or the appearance of the specimen. If it has valid generic characters a genus founded upon it is valid, and other species may be referred to it; if it has family characters but no distinctive generic characters, a family name founded on the genus is valid, but no subsequent genera are to be synonymized with it except when species of those genera are known to occur in the locality and geological horizon of the older genotype species. In illustration a few cases may be cited:

1. *Anchippodus riparius* Leidy 1868, type a lower molar from the "Miocene" (? Oligocene) of New Jersey. Type of the family Anchippodontidæ Gill 1872, referred to the order Tillodontia Marsh 1875. Leidy referred to this genus and species in 1873, his *Trogosus castoridens* 1871 based on a lower jaw from the Middle Eocene (Bridger formation) of Wyoming and to the same genus Marsh's *Palæosyops minor* 1871, based on a lower molar. Marsh, subsequently obtaining complete skulls and skeletons of related animals, accepted Leidy's genus *Anchippodus*, described a new genus *Tillotherium* with three new species, and based upon it the family Tillotheridæ which he made typical of the order Tillodontia.

No topotypes of *Anchippodus riparius* are known. Subsequent authors have either followed Marsh in ignoring Gill's name, while accepting Leidy's identification of *Anchippodus* with *Trogosus*, and considering *Tillotherium* as distinct from the latter, or they have used Anchippodontidæ as the family name, while deriving all the characters of the group from Bridger materials.

The result is that the faunal lists record in the New Jersey "Miocene" along with a known Oligocene mammalian fauna (*Cænopus, Entelodon, Protapirus*) a genus and species of the Middle Eocene fauna, while the western collections make it reasonably certain that in those regions the family and order disappeared with the Middle Eocene. Were this conclusion supported by real evidence, it would lead to some interesting corollaries as to migration and survival. In fact it is quite misleading. The type of *Anchippodus riparius* is inadequate for specific or generic comparison, and doubtfully adequate for family or ordinal comparison. It is very improbable that it is congeneric with *Trogosus*, hardly possible that it is co-specific with *T. castoridens*, so far as one may judge from the associated fauna in absence of generic or specific characters in the type specimen. Gill's family characters were drawn from *Trogosus*, and since it is doubtful whether this genus belongs in the same family with *Anchippodus*, his family should be held as doubtfully synonymous with Tillotheriidæ, both names to be retained, but the former as "? Anchippodontidæ Gill, fam. indet."

2. *Hippodon* Leidy is the first genus of three-toed horses described from this country. The type is *H. speciosus*, based upon a lower molar tooth. Leidy subsequently referred to the species upper teeth, etc., which he considered congeneric with the older European genus *Hipparion*. On the basis of these and other referred specimens the species was held valid and the genus a synonym of *Hipparion* until Gidley revised the three-toed horses in 1907. No topotypes were or are known. Gidley set aside both genus and species as indeterminate. I subsequently identified and located the type specimen which had been missing, and after making a fairly careful com-

parison came to the conclusion that it was a species of *Merychippus*. A more thorough restudy of the Miocene horses last summer brought me to the conclusion that this tooth, while certainly distinct from *Hipparion*, lies somewhere near the border line between *Merychippus* and *Protohippus*, but on which side of the line I can not determine except arbitrarily. The species is, therefore, in fact indeterminate generically, and a valid genus can not be based upon it. *Hippodon* would, however, stand as the type of a group including *Merychippus, Protohippus* and *Pliohippus* as contrasted with *Hipparion* and *Neohipparion*. In stratigraphic correlation of the beds at Bijou Hill, where it was found, it would be listed under the Protohippinæ as *Hippodon speciosus* gen. et sp. indet.

3. *Deinodon* Leidy is determinable as to family, but is not determinable generically, as the genera of carnivorous dinosaurs are now distinguished. The same is true of a whole series of genera and species described by Leidy and Cope from the Judith River. The treatment of types and referred specimens of these genera by paleontologists as specifically distinguishable or identical has sadly misled Dr. Peale in his recent discussion of the vertebrate evidence as to the age of the Judith River beds, leading him to present as conclusive evidence of identity in age a correspondence in fauna which to those who know the nature of the specimens on which the lists are based is no evidence at all.

In brief the plea is for the full recognition of nomenclature laws, but for the avoidance of arbitrary or unprovable identifications in the future, and the recognition of the actual facts as to the extent to which described genera and species are truly determinable. The allowed exception in the case of topotypes is based upon an inference of identity which it would seem impossible ever to prove incorrect. In all other cases the chances that future discovery may upset an arbitrary identification should prevent its being used as a basis for changes in nomenclature.

The source of the present lamentable situation in nomenclature is that an excellent system of procedure, designed to settle unsettled questions, has been wrenched from its intent and used to unsettle settled questions. The present writer, having studied with more or less care the majority of the type specimens of American fossil mammals and reptiles, has abundant evidence at his command to upset by a strict application of the accepted laws and procedures, much of the present nomenclature, including many of the alterations proposed in recent years upon grounds of priority. But he has no intention of so misusing his opportunities, or of being responsible for such changes until convinced that they will really result in greater stability.

W. D. Matthew

HOW IS THE WORD FOOD TO BE DEFINED?

The query expressed in the title "How is the word 'food' to be defined?" is suggested by a restrictive usage of this word which is rather prevalent in American text-books of elementary botany, and which seems to have originated among American plant physiologists. Presumably it had its birth in university courses in botany where the arguments for its use were given and understood, but as it appears in the elementary texts, it involves a marked inconsistency of thought and expression for which no provision is made. Since it represents a striking divergence from the ordinary meaning of the term "food," it deserves wider consideration, looking either toward its general adoption, if desirable, or else toward its discontinuance.

The word *food*, according to its ordinary connotation, is applied to any substance which, when taken into the body of an organism, can be used by that organism in the construction of new tissue. Definitions of essentially this content are to be found in the Century, Standard and Webster dictionaries. Using this definition as a basis, we should consider as food for green plants the water, carbon dioxide and mineral salts absorbed from the surroundings. According, however, to the restricted usage, these are not considered as "foods," but are referred to as "raw materials," "nutrients," "food materials," or some other cir-

cumlocution. Bergen and Davis[1] have a sentence which shows clearly how the restricted usage conflicts with the general usage illustrated by the definition given above:

> The series of processes by which the plant (1) takes in *raw material* to form its *foods*, (2) unites these into *foods*, and finally (3) constructs tissue from these *foods* or (4) stores them, constitutes nutrition.

Gager in a recent book-review[2] has given another excellent illustration of the same conflict of usages in the sentence which follows:

> On page 38, mineral *nutrients* are erroneously called plant *food*. [The italics of both quotations are mine.]

Judging from these quotations, it is evident that the content of the newer usage is entirely different from the older general usage. Carbon dioxide, water and mineral salts, all clearly to be classed as plant food under the older definitions, can not be so classed according to the newer usage. By a process of exclusion, after a consideration of the quotations just given, we arrive at the following new definition of the word food, viz., *organic materials available for immediate assimilation.* It appears, however, from other discussions that the intentions of the proponents is to apply the term food also to the organic raw material used by animals or colorless plants.

Two questions arise from the foregoing consideration: (1) Why has the new meaning of "food" arisen? (2) Does it deserve to prevail?

The arguments for the restricted usage are derived mainly from a comparison of the nutrition of green plants with that of animals. The food of an animal is chemically practically the same material as the tissues of the animal and consists of proteins, oils, fats and carbohydrates. (Mineral matter may be excluded from the consideration for the present.) During the process of digestion, this food is temporarily simplified as far as may be necessary to make it soluble. Assimilation consists merely in the reconstruction of compounds in general like those found in the original food. In the case of green plants, all the materials obtained from the surroundings are simple inorganic substances. The process of preparing them for assimilation is a complex synthesis, carried on by means of energy derived from an external source. At the end of this process we find ready for assimilation substances of the same sort as those which result from animal digestion. The ensuing process of assimilation is the same in green plants as in animals. These differences and similarities in materials and processes form the basis for the revised definition of the word food.

The reasons for adopting the new definition have been discussed in detail by Barnes.[3] They may be briefly recapitulated as follows: Protoplasm, being the same in green plants as in animals and colorless plants, and the material which it can actually assimilate being always organic, it creates an undesirable antithesis in thought to recognize as food for living things both inorganic and organic substances. Carbon dioxide and water if recognized as food for green plants can be so considered only for the chlorophyl-bearing cells, and for these only in the presence of light. They can not be used as food by the chlorophyl-less cells at any time, or for green cells in the absence of light.

Notwithstanding the weight and authority of the arguments in favor of restricting the meaning of the word food, there are numerous objections which should be given consideration.

One of the principal objections to be noted arises from the fact that the difficulty noted by Barnes and others is mainly of academic interest. So far as I have been able to discover, the question has been discussed only in two treatises of plant physiology designed for use by university students (Barnes and Green). Apparently, then, to be thoroughly conversant with the new usage, it is necessary

[1] "Principles of Botany," p. 106, 1906.

[2] Payne's "Manual of Experimental Botany," *Torreya*, 12: 134.

[3] Coulter, Barnes and Cowles, "Physiology," 3: 356–8.

to have used one of these texts or to have pursued an equivalent course in plant physiology.

Correlated with the objection just noted is another concerned mainly with the teaching of the restricted usage in courses in elementary botany in secondary schools. The clearest approach in beginning a course in botany in a high school lies in leading the pupil to think of plants as separate living things, each of which is an individual, which has, like an animal, its problems of food getting, nourishment, protection, etc. The university concept of the word food, however, requires that the pupil think of a green plant as an aggregate of different kinds of cells which bears a very different relation to its surroundings as regards its food than the living things, *i. e.*, animals, with which the pupil is familiar. The pupil thus loses the definiteness of the idea of a green plant as an individual with problems like those of animals, and has to think of it as something which does not get its food from without, but must manufacture it within its cells. The phraseology of this usage of the word food has been written into the elementary texts without, so far as I have been able to find, any attempt to make the pupil understand how or why it differs from the older usage. As a consequence he learns to use the word food, in the class at least, in a very different way from his ordinary understanding of it, but usually without any realization of the inconsistency.

Complications follow the restriction in meaning which do not appear to have been realized. In the case of green plants food, in the restricted sense, includes only organic material prepared within the cells of the plant and available for assimilation by any of the cells. In the case of animals, food is first, the organic material which, if taken into the alimentary tract, is able to be digested, and second, the material resulting from such digestion, even yet extra-cellular, but comparable with the material recognized as "food" of green plants. Thus it appears that future dictionaries will need to give at least two definitions of the word food.

If we accept the modified definition of food as desirable, we shall then have to face the task of making it part of the common knowledge of all who use the English language. Under present conditions it is practicable to teach it only to the minute proportion who pursue courses in plant physiology in colleges.

Referring to the antithesis in thought to which Barnes objected, it may be noted that this has apparently given little or no trouble to a number of well-known botanists who have discussed plant nutrition in text-books. It appears to have occasioned no difficulty in the elementary texts of Atkinson and McDougal; in the general texts of Bessey, Sachs, Strasburger, etc.; in the physiological treatise of Jost. Ganong in his text-book of physiology refers to the restricted meaning as desirable but as probably impossible to promulgate.

It seems to the writer as entirely unnecessary to attempt to make so great a distinction between the food material of the individual green plant as a whole and the food material of its constituent cells, or between the crude food materials of green plants and animals. It is possible sufficiently to differentiate the materials and their processes of preparation without revising out of conscience the ordinary meaning of an old and useful word. It would appear sufficient to satisfy all the needs of discrimination to use expressions like "crude food" and "cell food." [Since the preceding sentence was written, practically the usage suggested there has been used in high school classes with good results. The use of the expression "cell food" emphasizes to pupils the idea of the cells as the unit of structure and function in living things.]

Finally it may be noted that in the last analysis, it is strictly impossible to restrict the word food wholly to organic material. Barnes limited his discussion of the question to carbon dioxide and water and the carbon compounds resulting therefrom. He expressly excludes mineral salts from his consideration as too small in amount to deserve attention. Logically, however, they can not be excluded even on this basis and especially not in view of the fact that the nitrogen, sulphur and phosphorus of protoplasm are derived from

mineral matter. Moreover, although it is relatively easy to distinguish between CO_2 and H_2O on the one hand as inorganic "food materials," and sugars, starches, etc., on the other hand as manufactured "foods," who can say when nitrogen, sulphur and phosphorus cease to be "food materials" and become "foods"? Is it not more than probable, also, that some constituents of the mineral material taken in by plants and animals are immediately available for assimilation in the form absorbed, and are thus foods in both the restricted and broader senses of the word? If the facts are as here suggested, it is clearly impossible to limit the term food to organic material, first because too little is known of the metabolic processes by which nitrogen, sulphur, phosphorus, et al., are assimilated to enable any one to say at what stage these elements cease to be parts of inorganic and become parts of organic compounds, and second, because some inorganic substances are probably *foods* in both senses of the word.

In conclusion, the question asked in the title may be repeated. How is the word food to be defined? Is it to be limited to organic substances with all the pedagogic and scientific difficulties which such limitation entails? Or shall it remain as at present, raising no practical difficulties whatever and leaving the academic difficulties involved to be dealt with when the pupil becomes sufficiently mature to understand them?

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A STANDARD FORM OF COMMITTEE MEETINGS

DISTANCES in the United States are so great that it is often impossible for a committee to hold a meeting, and its work must be done by correspondence. Owing to the international, or national, character of many committees, and the increasing amount of friendly cooperation among scientific men, some standard system of arriving at results is greatly needed. It would then only be necessary when appointing a committee to state that its work would be done in this way, and the chairman would be saved the necessity of devising a method in each case, and the doubt in many cases, whether he was justified in appending the names of all members to his report.

The following method is accordingly suggested: The chairman or secretary should have three letters manifolded, and sent in due course to each member of the committee. The first of these should state the exact terms of the appointment; the objects desired; a request for suggestions for the report; an opinion whether a meeting is advisable, and if so, when and where.

The second letter should contain a preliminary report embodying the suggestions received, and in cases of doubt asking numbered questions to which, if possible, the answer will be yes, doubtful, disapprove, or no. In the first three cases, the writer accepts the views of the majority of the committee. In all four cases, he authorizes his name to be attached to the report, provided that it contains a statement that he dissents from the questions to which his reply is no. Prompt answers are requested, but if any member fails to reply after a letter has been in his hands for a week, the chairman may assume that he assents.

The third letter should contain the proposed report, to which all the names would be attached unless answers were received expressing dissent. Some of the members might prefer to make a minority report. If no reply was received to letters one and two, letter three should be registered with a request for a receipt, as otherwise the previous letters might not have been received. If haste is important, night letters are generally to be preferred to telegrams, since the delay from the most distant points of the country would seldom exceed twenty-four hours. If a reply by cable is necessary, the chairman should give his cable address, and if possible arrange all his questions so that each answer shall consist of only one or two words. A reply by cable, in which the fifth question related to a place of meeting, might read: Fieldsmith, Washington. One, two, yes; three, no; four, doubtful; five, London, July. Brown.

EDWARD C. PICKERING

May 6, 1913

QUOTATIONS

UNIVERSITY LIFE IN KANSAS

The vague feeling of unrest that has prevailed among the members of the university faculty on account of sweeping changes that might be made by the new board of administration has deepened into real alarm with the announcement from the board that all positions at the university have been declared open.

This is understood to mean that when the new board takes charge formally July 1, the entire faculty must be reengaged. The fact that a member has been elected a permanent member of the faculty by the board of regents in previous years after serving an apprentice term of years would not necessarily count at all with the new board. The board has by its announcement indicated that it will feel free to drop any member of the faculty it pleases.

That such will be the attitude of the new board is indicated by its action at a meeting last week when Chancellor Strong and President Waters were "reelected" to the positions they now occupy. As there was no definite limit to their "terms" it is hard to explain the action of the board other than by the supposition that it is its intention to wipe the slate clean and build the university anew "from the ground up." If any person has a position on the faculty after July 1, he will hold it directly from the new board of administration and not by virtue of the fact that he has grown old in the service of the institution.

Naturally, this plan of procedure has made the faculty very uneasy. It has been customary to reelect a new member for a number of years, until he had proved his worth to the institution, and then the regents would elect him a "permanent member" of the faculty. Under the new rule the old members are placed in the same boat with instructors of a single year's standing. None of them will know until after the "election" whether they are to be turned on the faculty. It is not an uncommon thing for a professor to have enemies. How is he to know that his enemies may not have the ear of the board, spreading little stories that reflect upon him? The old board of regents made it a practise to pay very little attention to such stories, although they heard plenty of them. But what the new board will do is entirely a matter of conjecture.

The most envied members of the faculty at the present time are those who have had offers of situations elsewhere. Of course everything may turn out all right, but, on the other hand, men who otherwise would have nothing to be alarmed at may be eliminated when the new broom begins to give its exhibition of clean sweeping. And a good many teachers have remarked privately in the last few months that they intended to take the first fair offer from elsewhere that presented itself. The talk about abolishing and consolidating and transferring courses was enough to make them uneasy, but the announcement now made that every teacher is likely to be treated as if he were for the first time an applicant for a position at the university has caused a decided feeling of insecurity.—*Lawrence Gazette.*

SCIENTIFIC BOOKS

A History of European Thought in the Nineteenth Century. By John Theodore Merz. Vol. III. (Part II., Philosophical Thought). New York, Charles Scribner's Sons. 1912. Pp. xiii + 646.

Nothing so well illustrates the profound interest of the great subject undertaken by Dr. Merz as the contrast between his work and Whewell's "History of the Inductive Sciences" (3d ed., New York, 1858). The evident superiority of the later history, especially in intensive treatment and exact *Facharbeit,* is in itself an index of the wonderful progress that characterized the nineteenth century, notably after "The Origin of Species." Fortunately, too, Dr. Merz has been content to take time. His first volume was published in 1896 (3d ed., 1907), and in it he grappled with the physical sciences. The second volume followed at an interval of seven years, and completed the task, as concerned the "sciences of nature." These volumes should be in the hands of every builder of "natural knowledge." It is to be hoped that the appearance of the

volume now before us will lend new stimulus to the sale of its predecessors. A fourth and concluding volume is yet to follow. But we have evidence, and to spare, that, once more, an Englishman of business affairs has arisen to occupy a place alongside George Grote and many others (Darwin not least) who, without academic support or connections, have accomplished so much for the advancement of British science, and the preservation of its distinctive temperament. As it stands, "A History of European Thought in the Nineteenth Century" is a magnificent performance. To the patient thoroughness of the German, Dr. Merz has added the clearness and, in the best meaning, the common-sense of his own countrymen. He carries his load without the aid of any partisan theory, he has no pet ideas to exploit. And although, the very nature of the case preventing, I am not yet convinced that his discussion of philosophical thought is as successful as his presentation of scientific achievement, nevertheless it is plain that Part II. bids fair to be as invaluable as Part I.

The volume contains six chapters: Introductory; On the Growth and Diffusion of the Critical Spirit; Of the Soul; Of Knowledge; Of Reality; and Of Nature. The plan demands some elucidation. Dr. Merz points out that "In the beginning of the century, both in Germany and England, science and scientific thought played only a secondary part in literature and teaching. France was the only country in which it had early acquired that position and commanded that esteem which it now enjoys everywhere" (p. 91). The nineteenth century brought about a change which "amounts in many cases to a complete reversal of the estimation in which the mathematical and natural sciences, on the one hand, the historical and philosophical, on the other, are held. The earlier part of this history has furnished the answer to the first half of the problem: I there endeavored to show that the success and assurance of scientific thought has grown with the growth and diffusion of the scientific spirit, which has been more clearly defined as the exact or mathematical spirit. . . . The second part of this history will have to answer the other half of the above question, namely, what are the causes that have brought about that great change in the general and popular appreciation of philosophical discussions? How is it that instead of one or two dominant systems of thought we have now what may be called a complete anarchy, or, at best, a bewildering electicism? . . . I will at once answer this question. The great change referred to is owing to the growth and diffusion of the critical spirit, taking this term in its widest sense" (pp. 93–95). Accordingly, the scene being thus shifted, there is no little need of the warning that Dr. Merz is careful to issue. "I think it will be more helpful to my readers if, when entering on a new portion of my subject, I immediately impress upon them the necessity of adopting an entirely different point of view from that to which they may have become accustomed by the perusal of the former volumes. So strongly do I feel the necessity of this, that I am inclined to say that, except they are prepared to familiarize themselves with an entirely altered set of interests, problems and methods, I shall fail to gain, or to retain, their attention in that which follows" (p. 34). This, then, indicates the general setting.

The method employed to reach the special divisions is also set forth clearly. "The dualism which pervades all modern thought will occupy us quite as much as the attempts towards unification" (p. 56). "In Leibniz philosophical thought arrived at the position which, with certain interruptions, it still occupies at the present day; its task being, not to afford new knowledge, but to mediate between the claims of two kinds of knowledge: that which deals with things surrounding us in time and space, and that which deals with the highest questions of our life, our destiny, and our duties" (pp. 334–335). Thus, following Kant's famous pronouncement, at the close of the "Critique of Practical Reason," Dr. Merz finds himself confronted with two central problems. "The first begins with the place which I occupy in the outer world of the senses and expands the connections in which I stand into the invisibly great, with worlds upon worlds

and systems upon systems, moreover, into limitless ages of their periodic motion, its origin and duration. The second begins with my invisible Self, my personality, and represents me as standing in a world which has true Infinity, but is accessible only to Reason." Each of these problems, in turn, splits into several parts. Therefore, Dr. Merz proclaims: "I am not primarily interested in expounding the different philosophical systems, but rather in tracing the leading ideas which have survived these systems themselves and become the common property of the philosophical mind at the present day. . . . As we saw that the scientific activity of the century resulted in the firm establishment of a small number of leading conceptions, so I shall now endeavor to show how the huge and frequently conflicting philosophical literature has left behind it a small body of guiding ideas which form the enduring bequest of nineteenth-century speculation" (pp. 39–41). Hence, "looking at the different national interests which promoted philosophical thought in the three countries [*i. e.*, England, Germany and France], we are led to a first division of this great subject which is given by the terms psychological, metaphysical and positive" (pp. 45–46). Besides this, there is the sphere of individual beliefs and convictions which "have quite as much the right to be regarded as facts as any more definite, scientific or historical knowledge" (p. 53). The latter are to be treated in Vol. IV., and again in six chapters: Of the Beautiful; Of the Good; Of the Spirit; Of Society; Of Systems of Philosophy; and "will close with a summary of the general outcome of Philosophical Thought during the Nineteenth Century" (p. vi). Of the former, now before us, but one seems to call for further comment, the rest are self-explanatory. In these days, what does Dr. Merz mean by "Of the Soul"? He answers: "I have headed this first chapter which deals with a definite philosophical problem: 'Of the Soul.' I might have chosen several other words which would have equally introduced us into that portion of philosophical literature with which I am now concerned. . . . That I nevertheless prefer to speak of the soul and not of the human mind or human nature, may be justified by the fact that the word soul introduces us at once to a historical discussion which took place in the middle of the century in Germany, and which may be considered to mark one of the great changes that have come over our way of regarding all questions connected with the mental life. What was called at the time 'Die Seelenfrage' occupied the foremost place in philosophical discussions carried on both by philosophers and naturalists. . . . It seems appropriate to start the history of philosophical thought with an account of the problems which center in the word soul" (pp. 196–199).

Thanks to limits of space and to the fact that technical criticism of philosophy is out of place here, I must content myself with a few summary remarks about the contents of the book. The introductory chapter offers an admirable review of the temperamental differences between science and philosophy, and of the conditions that governed reflective thought throughout last century; while the chapter on the critical spirit is the best synopsis of the historical sciences within my knowledge. Seeing that the scientific and critical movements are the twin intellectual achievements of modern thought, and that the one can not be understood apart from the other, this distilled statement should prove most illuminating to all workers in the physical and biological fields.

Turning to the philosophical chapters, the point of view may be hinted. It is sufficient to say, perhaps, that Dr. Merz deems Lotze the most typical and discriminating thinker of the age. Consequently, he tends to pivot German thought upon the Göttingen professor and, as a sequel, to lay much stress upon Renouvier for French and Professor James Ward for English philosophy. Seeing that Renouvier has not dominated French thought at any time, and that Dr. Ward has never wielded such influence in Britain as Green, the Cairds, Wallace and Bradley, this view seems difficult to maintain. Despite Lotze's failure to found a "school" in Germany, Dr.

Merz's contention may be justified from a purely historical standpoint, although, even here, I have grave doubts (*cf.* pp. 266 f.). For, the clear statement of Lotze's position (pp. 501 f.) amounts to a fatal criticism philosophically! The single proposition—"relations which endure and events that happen, imply things in and between which they subsist" (p. 502)—is in itself sufficient condemnation. Another interesting feature, interesting especially to scientific men, is the rehabilitation of Schelling (pp. 453 f.), who, we are told, "deserves to be looked upon as the central figure during the idealistic period of German philosophy" (p. 453). Now, although Dr. Merz seems to me to begrudge the immense influence of Hegel, he is bold enough to affirm that "Hegel deserves to be looked upon as the greatest representative of philosophical thought in the nineteenth century" (p. 476). Of this there can be no question, I think. But how this conclusion, which Hegel literally wrings, as it were, from Dr. Merz, is to be reconciled with the primacy accorded to Schelling is hard to understand. Nevertheless, the appreciation of Schelling, and particularly the effort to remove the misconception that has been heaped upon him, was greatly in need. Omitting many other notable matters, I would simply record that the chapter on knowledge is, in my judgment, the most successful; while the discussion of the problem of nature is the most suggestive, so much so, that it can not fail to appeal to followers of the natural sciences. Dr. Merz handles the vast wealth of material with astonishing skill, intimacy and perspicacity.

As was inevitable in work done on so large a scale, there are some few unguarded statements. I can not but think that the tendency to separate sharply between "outer" and "inner" results in a false contrast (p. 12). It would be much nearer the truth to say of D. F. Strauss, that the issues he raised were misunderstood by his own contemporaries, than that "the conclusions he came to were premature" (p. 169). It is doubtful, if no more, whether any such relation between Hume and Kant as is put forward for fact (p. 229) could be proven historically. The remark about psychology (p. 252) is scarcely in focus. For, even granted that the old psychology disappeared, we had ample compensation in *Völkerpsychologie* and *Sprachwissenschaft*, both traceable to the very movement which Dr. Merz tends to condemn. Indeed, the main defect of the "History" is to be found precisely in its prevalent tendency to minimize this same movement. There is an astonishing misconception of Fichte's problem (p. 234), and a curious comment about Spencer's knowledge of Kant (p. 296), whom, as Spencer himself informs us, he could not read. It ought to be noted, finally, that the scope of the work is not European. Dr. Merz really confines himself to the three leading nations—France, Britain and Germany. The omission of Italy, particularly after the work accomplished by her when her political unification was won, is to be regretted. But, we should not look a gift horse in the mouth. These are mere blemishes, never blots, on a very remarkable achievement.

The publishers (Blackwoods, Edinburgh) ought to have their share of commendation. Considering the size of the volume, and the elaborate notes with which it literally swarms, the press work is exceptionally free from errors. A letter dropped in the marginal summary (p. 12); J. F. for J. H. Tufts (p. 57 n.); J. M. for T. M. Lindsay (p. 209 n.); Taylor for Tayler (p. 306 n.); Eucken's work (p. 436 n.) is not a "little tract"; Thompson for Thomson (p. 612 n.)—an insignificant total. The index is excellent—a most important consideration in so voluminous a performance. Dr. Merz promises that, "when the fourth volume appears," it "will be cancelled to make place for a more comprehensive index covering both volumes" (p. vi). In these circumstances, I venture to append a list of errors for correction then. Under De Morgan, "Study of . . . Metaphysics, 576" should read Study of . . . Mathematics, 376; "M'Cormick" should read McCormack; there is a reference (p. 165 n.) omitted under "Lexis." "Ravaisson-Mollien" is misleading. Ravaisson did adopt the name of his maternal

uncle, but not till after his classical "Rapport" (of 1867, not 1868, as on pp. 201, 234, 426); quite rightly, he is always referred to in the text by his paternal name, without the later addition, and should be so noted in the index. Under "Schiller" philosophy has been substituted for history. "Ænesidemus" is correctly printed under "Schulze, G. E.," incorrectly on p. i of the index. Under "Ueberweg," T. M. should be substituted for J. M. Lindsay; and "Taylor" should read Tayler. The caption "Cause and effect defined" should be thoroughly revised and extended. There are several references in the text of far greater importance than the single one recorded in the index.

R. M. Wenley

Ann Arbor

Electrical Machine Design. By Alexander Gray. McGraw Hill Book Company.

"Electrical Machine Design," by Alexander Gray, discusses the theory of operation and design of direct current generators and motors of both interpole and non-interpole type, alternating current generators, induction motors and transformers. Five hundred and seven pages are not enough to cover such a range of subjects satisfactorily, and when the analysis of theory is carried to the extent attempted by Mr. Gray the result can not be a success. Considered as a text-book, it would be unsuited to the average fourth-year student, not because the analyses are too involved for such, but because their introductions are too brief. The calculation of temperature gradient may be taken as an example. If a few paragraphs had been inserted discussing the laws governing flow of heat, and containing perhaps a simple application, the subsequent treatment would have been much more easily understood. The same criticism is applicable to the chapter on armature reactions in alternators.

Considered as a book for reference purposes, this work contains much matter of value, both to the student and to the designer. Discussions of such questions as noise of induction motors, comparative value of shell and core type transformers, short pitch windings in direct current machines, are really valuable and are not to be found readily elsewhere. The subjects of commutation and insulation are very well developed.

The arrangement of subject matter is usually excellent. The treatment of the induction motor had better have followed that of the transformer instead of preceding it. Such an arrangement would have made possible the consideration of the induction motor as a transformer, a most practical and effective method. The theory of operation and construction of each type of apparatus is first developed. This is followed by the procedure in design, the discussion of special types of machines, and a chapter on specifications. Examples accompany the text and should aid the student materially in his comprehension of the subject.

The book compares favorably with the other books on design in our language, but when it is contrasted with the simple and extremely logical treatments to be found in the works of Arnold, its own shortcomings are most apparent.

C. W. Green

METEOROLOGICAL OBSERVATIONS AT THE UNIVERSITY OF CALIFORNIA

It is probably due to the fact that the public interest in meteorology is centered around weather forecasts that the science has received so little attention from the universities of the United States. The University of California is one of the relatively small number which has maintained a regular series of observations for a considerable period.

Until July 1, 1912, when the routine meteorological work at Berkeley was transferred to the department of geography under which the courses in meteorology and climatology are listed, the astronomy departments, the Lick Observatory at Mount Hamilton and the Students' Observatory at Berkeley, carried on the principal meteorological observations of the university. Meteorological observations have always been a part of the regular work of the Lick Observatory and, when the Students' Observatory was established at Berkeley, its ac-

tivities included meteorological work as a voluntary observer's station of the United States Signal Service. The first rain-gauge was set up on October 16, 1886, and the meteorological work may be dated from that time. A synopsis of the results of the observations for the twenty-five years ending July 1, 1912, has been prepared by the director of the observatory and is soon to be published in the University of California Publications in Geography, which will contain, among other geographic papers, the results of the meteorological observations and climatic studies made at the University of California.

There is, perhaps, no type of work in which so much depends upon the daily exacting attention to detail as meteorology. An observation missed in this work is lost forever; an approximate figure may be obtained and used in the preparation of the averages, but the greatest value of meteorological work depends upon an unbroken and regular series of observations. Such a series is that which was obtained by the Students' Observatory at Berkeley during a period of nearly twenty-six years. From the establishment of the meteorological station until September, 1892, the observations were made three times daily, at 7 A.M., 2 P.M. and 9 P.M., and the results sent to the signal service at the end of each month. From September 1, 1892, observations have been made at 8 A.M. and 8 P.M., Pacific Standard Time, the standard time in use in the state of California. The transfer of the meteorological work from the signal service of the War Department to the Weather Bureau of the United States Department of Agriculture in no way broke the continuity of the record at Berkeley; the relations which were established with the signal service have been continued with the Weather Bureau.

The plans of the signal service for the work of the voluntary observers proved to be somewhat more detailed than seemed desirable under the conditions of the service and in the early nineties a simplified form of report was adopted. As far as the reports to the Weather Bureau were concerned the University of California conformed to the new plan; but the observations at Berkeley were maintained on the same plan as before, as there was nothing inconsistent with this in the new form, with the result that the record kept by the university is exceptionally complete.

In addition to the reports which have been sent to the Weather Bureau and printed in its publications, the university has issued a monthly meteorological synopsis of Berkeley regularly since the beginning of 1887. General synopses have been prepared by Professor Leuschner, the director of the Students' Observatory, and published at five-year intervals, which have summarized the results, as shown by the monthly synopses, up to the date of the general summary. The monthly synopses have been continued by the department of geography in a somewhat enlarged form. It is also proposed to publish an annual report in conformity with the suggestion of the International Meteorological Committee. The original record is in such good condition that, when it was decided to change the method of compiling and stating some of the data in order to bring the form of the synopsis into accord with the better practise, this could be easily accomplished without the use of approximations, and without breaking the series.

There is no scientific work which will continue itself for any considerable length of time without the persistent efforts of men. The meteorological work at Berkeley depends largely upon the efforts of the directors and the Students' Observatory. With the advice of the signal service and the approval of the University of California Professor Frank Soulé, the first director, conceived the idea of making meteorological observations at the observatory, and began the work which has continued since that time. In 1892 he was succeeded as director by Professor A. O. Leuschner, who has maintained the record at its high standard for the past twenty years. The actual observations have been made by various members of the staff of the observatory; and their faithful and punctual performance of an exacting and often unin-

teresting routine duty gives the record its value.

The meteorological work has now come under the direction of the writer as a part of the work of the department of geography. The observations are made at 8 A.M. and 8 P.M., 120th meridian time, besides which there are continuous records of pressure, temperature and relative humidity from the recording instruments. The eye observations are now as follows: wet and dry bulb thermometer readings, maximum and minimum temperatures for the preceding twelve hours, air pressure, wind direction and estimated velocity, amount of cloud, weather and precipitation during the preceding twelve hours. The data are summarized and published monthly in the *Meteorological Synopsis* of Berkeley and a monthly report is made to the United States Weather Bureau on the regular form of report for the cooperative observers.

The University of California has for Berkeley and for Mount Hamilton meteorological records of considerable length and more complete than exist for many places in the United States not regular stations of the Weather Bureau. In a state where climate is such an important factor in the life of the people as it is in California, it is proper that the educational institutions, but above all the state university, should pay more than ordinary attention to meteorology.

WILLIAM G. REED

BERKELEY, CAL.,
March 1, 1913

REVIEW OF FOREST SERVICE INVESTIGATIONS[1]

THE new periodical issued by the Forest Service, the *Review of Forest Service Investigations,* is the direct outcome of the standardization and coordination of the investigative work done by the service. This investigative work has been placed on a more solid footing by the establishment of investigative committees in each district and of a central investigative committee in Washington.

[1] Volume I., issued March 11, 1913, by U. S. Department of Agriculture, Forest Service.

The *Review* is to serve as a medium for keeping foresters in touch with the scientific work of the profession in America. It will do this by publishing progress reports on major investigations the completion of which will require a number of years, during which time nothing would otherwise be known of them; by publishing full reports on minor studies not of sufficient importance to warrant publication as separate bulletins or circulars, but which nevertheless contain valuable material; and by giving a general view of the scientific forest problems in this country and of what is being done toward their solution. In short, the district and central investigative committees and the *Review* represent the crystallization of the scientific work of the Forest Service; they will make possible a very much higher degree of efficiency.

The present number, being the first, is purely preliminary. It gives no conclusions or reports of investigations, but shows the organization and classification of the scientific work of the Forest Service, the problems in need of solution, and, in general, the manner of attacking these problems. It gives the four main heads, Dendrology, Grazing, Products and Silviculture, with their subdivisions, and describes concisely the problems to be studied under each subdivision. Under Dendrology it shows the importance of studies of tree distribution and of wood structure. Under Grazing, work is being done to collect basic information on the forage, to find methods of reseeding the more valuable kinds, both artificially and naturally, and ways of handling stock so as to increase the carrying capacity of the range, better the condition of the stock, and insure complete utilization of the forage. Under Products, investigations are being carried on to learn the properties of wood, mechanical, physical and structural, so that each kind can be put to its best use and handled most efficiently in manufacturing and kiln drying; to increase the knowledge of preservatives, including the methods of using them and their effects; to develop uses for products of trees other than saw

timber, such, for instance, as making alcohol from wood waste; in addition, Products is gathering much statistical information of use not only to the Forest Service, but to all wood-using industries. Products comes in closer contact with the lumber industry than any other branch of the service and has already secured results of great value to lumbermen. Under Silviculture, the *Review* gives in some detail the important problems on which the service is working. It describes briefly the establishment and purpose of the experiment stations; under each head (forestation, forest influences, management, etc.) it not only gives the problems to be studied, but shows their importance and their relation to each other. The experiment being conducted at Wagon Wheel Gap to determine the influence of forest cover on run off and erosion is given rather fully. This is probably the most complete and far-reaching experiment of its kind in the world.

At the end of the *Review* is the investigative program for 1912. A study of this program will show the thoroughness with which the field is being covered.

Barrington Moore

Washington, D. C.

SPECIAL ARTICLES

A LABORATORY METHOD OF DEMONSTRATING THE EARTH'S ROTATION

The two laboratory methods in general use for proving the rotation of the earth are Foucault's pendulum and gyroscope experiments. The first is inapplicable in many laboratories, because there is no convenient place to hang a sufficiently long and heavy pendulum, while the apparatus for the second is necessarily expensive. The following experiment is designed to provide a simple and convenient means by which the earth's rotation may be demonstrated in a small laboratory. The demonstration depends upon the fact that, if a circular tube filled with water is placed in a plane perpendicular to the earth's axis, the upper part of the tube with the water in it is moving toward the east with respect to the lower part. If the tube is quickly rotated through 180 degrees about its east and west diameter as an axis, the part of the tube which was on the upper side attains a relatively westward motion as it is turned downwards (since it is drawing nearer the earth's axis). But the water in this part of the tube retains a large part of its original eastward motion, and this can be detected by suitable means.

Since the east and west axis itself is rotating with the earth, only that component of the water's momentum which is parallel to this axis will have an effect in producing a relative motion when the tube is turned. If then a is the angular velocity of the earth's rotation, r the radius of the circle into which the tube is bent, and θ the angular distance of any small portion of the tube from the east and west axis, the relative velocity between the water and the tube when it is quickly turned from a position perpendicular to the earth's axis through 180 degrees is

$$\text{Velocity} = V = \frac{ar}{\pi}\int_0^{2\pi} \sin^2\theta d\theta = ar.$$

In order to prevent convection currents, it is best to hold the ring normally in a horizontal position, in which case the relative motion is of course $ar \sin \phi$, where ϕ is the latitude of the experimenter.

To perform the experiment, glass tubing 1.3 cm. inside diameter was bent into a circular ring 99.3 cm. in radius, and a short glass tube closed with a rubber tube and screw

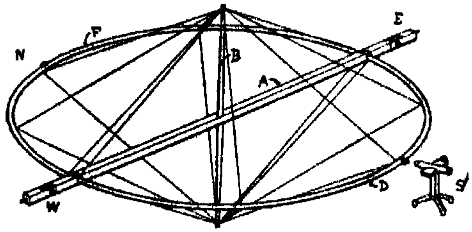

Fig. 1

clamp was sealed into it to allow for the expansion of the water and to provide a place for filling. The ring was fastened with tape into notches in the wooden rod A (Fig. 1), which served as the horizontal axis, and was

supported by wires from the extremities of the cross rod *B*. The ends of the rod *A* were made adjustable perpendicularly to the plane of the ring, so that the ring might be made to swing on an axis parallel to its plane. The ends of the rod were swung in solid supports, adjustable to make the axis horizontal. In order that the motion of the water might be detected, a mixture of linseed oil and oil of cloves of the same density as water was prepared, and a few drops of the mixture were shaken up with the water with which the tube was to be filled. The globules of oil were observed at a point *C*, between the ends of the axis, through a micrometer microscope. Difficulties from the astigmatic refraction of the light by the water in the cylindrical glass tube were overcome by sealing a tubular paraffine cap, closed with a cover-glass and filled with water, on the part of the glass tube under the microscope, thus presenting a plane surface through which to make the observation. One side of the ring was weighted, so that on releasing a catch at the side of the observer the tube swung around through 180 degrees in a definite time, and was held again by the catch just under the microscope.

In taking a reading, the microscope was focused as nearly as possible on the center of the tube, and the ring was left in position until the oil globules had no appreciable motion. As soon as the catch which held the ring in position was released, the time was counted, with the aid of a metronome ticking half-seconds, until the tube had turned and an oil globule had been fixed upon to follow. The globule was followed through a measured length of time by turning the micrometer screw, and the distance through which it moved was recorded. Examples of these observations are given in the first three columns of Table I.

Variations in the readings arose from the fact that the part of the ring toward the east was near a cold wall, so that convection currents were produced as soon as the tube left the horizontal position in making a turn. This effect was made as small as possible by stirring the air with an electric fan. Other variations came from the fact that it was found impossible to adjust the horizontal axis so nearly parallel to the plane of the ring as to prevent a slight effect from turning the

TABLE I

Time from Releasing Catch to Following Water's Motion	Time of Following Water's Motion, Sec.	Distance Through which Water is Followed, Mm.	Time from Completion of Turn to Following Water's Motion, Sec.	Time on Curves of Completion of Turn	Initial Velocity, V, Mm. Sec^{-1}
Case I. Weight on side *D*. Change from heavy to light side.					
7.5 secs.	22.5	+ .40	4.5	+21.2	+.041
7.0	23.0	+ .37	4.0	+22.1	+.039
Case II. Weight on side *D*. Change from light to heavy side.					
7.5	22.5	+1.57	4.5	− 1.0	+.160
8.0	22.0	+1.35	5.0	+ .5	+.155
Case III. Weight on side *F*. Change from heavy to light side.					
8.0	22.0	− .59	5.0	+13.4	−.067
7.5	22.5	− .70	4.5	+11.4	−.075
Case IV. Weight on side *F*. Change from light to heavy side.					
7.5	22.5	+ .37	4.5	+19.9	+.045
8.0	22.0	+ .67	5.0	+11.5	+.075

Average V: Case I. = .0434; Case II. = .1580; Case III. = −.0633; Case IV. = .0671.

tube. Errors from the first cause were corrected by reversing the direction of turning in alternate readings. Those from the latter cause were nullified by taking readings with one side of the ring weighted and then shifting the weight to the other side. In this manner ten readings of each of four different kinds were taken (Cases I., II., III. and IV.), and the fact that the predominant motion is positive, or toward the west as observed on the south side, shows that the earth is turning from the west to the east.

Calculation of the Initial Velocity

In order to make an accurate estimate of the velocity corresponding to any given reading, the rate of decrease of velocity of the water in the ring must be determined. If the

retardation r is taken to be proportional to the velocity V for this low velocity,

$$r = \frac{dV}{dt} = CV,$$

$$\frac{dV}{V} = Cdt,$$

and

$$\log V = Ct + K$$

will express the value of the velocity at different times. In order to determine the constants C and K, the ring was held in a vertical position until the colder water near the east wall produced a considerable motion. It was then brought back to the horizontal and the time observed which was required to move successive quarter millimeters. A few

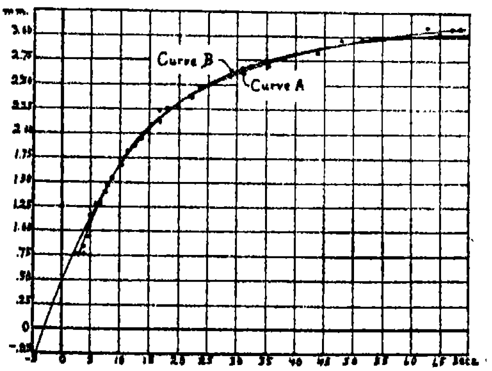

FIG. 2

such readings are given in Table II. From a large number of such observations an average curve was drawn, showing the relation of the distance covered to the time (Fig. 2, Curve A). The slope of this curve was taken at two

TABLE II

	.25	.50	.75	1.00	1.25	1.50	1.75	2.00	Distance in Mm.
1	2	4	7	11	16	22	30	42	Time in seconds.
2		2		5	7	10	15	21	
3	3	7	11	17	23	31	45	68	

of the most definite points, $t = 12.5$ and $t = 30$, and these values were substituted in equation (1) to determine the constants C and K. The curve in Fig. 3 was then drawn from the resulting formula, showing the velocity at any time. Curve B, Fig. 2, was then constructed by integrating this curve graphically with respect to t.

The water in the ring has its maximum velocity just before the turn is completed. The time required to make a complete turn was three seconds, and if this is subtracted from the time in column 1, Table I., it gives the length of time between the completion of the turn and the first observation of the motion (column 4, Table I.). Now if a portion of Curve B (Fig. 2) be taken, such that the distance represented on the curve in the time of any particular reading is the same as the distance in that reading, the beginning of that portion of the curve will correspond to the time at which the motion of the globules

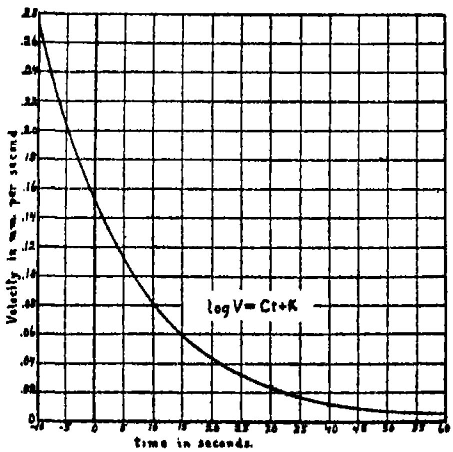

FIG. 3

was first observed (column 5, Table I.). So if the number of seconds in column four is subtracted from the time corresponding to the beginning of the reading, the time corresponding to the completion of the turn is obtained, and the velocity at that time can be read from the curve in Fig. 3. This value is given in column six, and is the velocity at the time of completing the turn. The velocities in each of the four cases are averaged separately, and the average of the four averages is taken as the true motion due to the earth's rotation.

The average of the velocities in these four cases is .0518 mm. per second. From the formula $V = \omega r \sin \phi$ derived above, we ob-

tain $V = .0484$, a difference of 5 per cent. As a check upon the accuracy of the readings, it will be seen that the differences between the velocities in Cases I. and II. and between those in III. and IV., representing double the velocity due to the difference in density of the water in different parts of the tube, are about equal; also the differences between Cases I. and III., and II. and IV., representing the variation due to imperfect adjustment of the axis, are approximately the same. In order to show that there was no appreciable effect from convection currents while the ring was in a horizontal position, several readings were taken after the tube had remained at rest for some time, none of which showed a motion larger than .015 mm. per second.

In order to obtain the best possible results, the ring should be mounted as rigidly as possible in a room of equal temperature throughout, and the axis should be capable of accurate adjustment parallel to the ring. If the radius of the ring were made smaller, although the effect of the earth's rotation would be less, it would be easier to keep all parts of the tube at an equal temperature, and the ring could be turned more quickly. Moreover, since the motion would not be so great, the velocity of the water would diminish less rapidly, so that more accurate readings could be obtained. With a more mobile liquid the motion would of course continue longer. Even with the comparatively crude apparatus described above, however, it is not difficult to show that the earth revolves.

ARTHUR HOLLY COMPTON
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UNIVERSITY OF WOOSTER,
January 13, 1913

CROSSOPTERYGIAN ANCESTRY OF THE AMPHIBIA

FOR many years evidence has been accumulating for the view that the Amphibia have been derived not from Dipnoi but from Crossopterygians of some sort. Pollard[1] held that the Amphibia were remotely related to the living *Polypterus* and Baur[2] was able to strengthen the evidence, to some extent, from the Stegocephalian side. More recently Thévenin[3] has expressed similar views, while Moodie,[4] correcting Baur's observations on the lateral line grooves in the skull has seemingly demonstrated the general homology of the skull top of *Polypterus* with that of Stegocephalia. Gegenbaur[5] supported the homology of the Stegocephalian cleithrum with the "clavicle" of *Polypterus* and other fishes, while Klaatsch[6] showed that the pectoral limbs of *Polypterus* both in musculature and osteology in many respects remotely suggest Amphibian conditions. On the other hand, Goodrich's[7] studies on the scales of fishes, together with the evidence offered especially by the brain of *Polypterus*, tend to remove that genus widely from genetic relationship with the Amphibia.

The Paleozoic Crossopterygii have hitherto yielded a few, though significant, hints of Amphibian relationship. The Texas Permian Crossopterygian fish named by Cope *Ectosteorhachis nitidus* and recently figured by Hussakof[8] as *Megalichthys nitidus*, suggests remote Stegocephalian affinities in the skull and the same is true of *Rhizodopsis*, as figured by Traquair[9] and of *Osteolepis*, as figured by

[1] "On the Anatomy and Phylogenetic Position of *Polypterus*," *Zoöl. Jahrb. Abt. f. Anat. u. Ont.* (Spengel), V. Bd., Jena, 1892, pp. 387–428, Taf. 27–30.

[2] "The Stegocephali. A Phylogenetic Study," *Anat. Anz.*, XI. Bd., 1896, No. 22, pp. 657–673.

[3] "Les Plus Anciens Quadrupèdes de France," *Annales de Pal.* (Boule), tome V., 1910, pp. 1–64, pl. I.–IX.

[4] "The Lateral Line System of Extinct Amphibia," *Journ. of Morphol.*, Vol. XIX., No. 2, 1908, pp. 511–540; 1 pl.

[5] "Clavicula und Cleithrum," *Morphol. Jahrb.*, XXIII. Bd., Leipzig, 1895, pp. 1–21.

[6] "Die Brustflosse der Crossopterygier," *Festschr. für Gegenbaur*, I. Bd., 1896, pp. 259–391, Taf. I.–IV.

[7] Cf. Lankester's "Treatise on Zoology," Part IX., first fascicle. "Cyclostomes and Fishes," by E. S. Goodrich, 1909, especially pp. 217–219, 290–300.

[8] "The Permian Fishes of North America," Publ. No. 146 Carnegie Institution of Washington, pp. 168 and pls. 30, 31.

[9] "On the Cranial Osteology of *Rhizodopsis*," *Trans. Roy. Soc. Edinburgh*, Vol. XXX., 1881.

Pander.[10] *Sauripterus* Hall, a supposed Rhizodont from the Upper Devonian of Pennsylvania has a pectoral girdle and forepaddle which distantly approach Stegocephalian conditions[11] and so also, but in less degree, has *Eusthenopteron*.[12]

Far more definite evidence of the supposed relationship of the Stegocephali with the Paleozoic Crossopterygii has recently been adduced by D. M. S. Watson,[13] of Manchester, in describing some of the large Stegocephalia of the Coal Measures preserved in the Newcastle Museum. He finds that the skulls of the Carboniferous Labyrinthdonts, "*Loxomma*" and *Pteroplax* reveal striking resemblances to the Carboniferous Crossopterygian *Megalichthys*:

The Basisphenoid of *Megalichthys* has sometimes carotid foramina just as in *Loxomma*. It has small but distinct basi-pterygoid processes which are, however, not provided with articulating surfaces but with sutural ones. The long parasphenoid extends forward to the premaxillæ as it may do in *Pteroplax*. Its lateral borders are in contact with the Pterygoids, to which they afford support, and the bone is connected with the roof of the skull by a fused ethmoid.

The pre-vomer is identical with that of "*Loxomma*" in the majority of its attachments, carries one large tusk and a pit for the replacing tooth. It meets its fellow of the opposite side and forms the front of the posterior naris; it is doubtful, however, if it meets the palatopterygoid.

The Palatopterygoid of *Megalichthys* is exceedingly like the palatine and pterygoid of *Pteroplax*. They have similar relations to the basisphenoid, parasphenoid and maxilla. There is the same row of small teeth parallel to those of the maxilla with larger teeth inside them, and the pterygoid is covered with the same shagreen of fine teeth.

Examination of these primitive and extremely well-preserved skulls seems to show that the ordinary idea of autostylism of the Tetrapoda is incorrect in postulating a connection between the pterygo-quadrate cartilage and the otic region. It is, I think, quite certain that there never was such a connection in primitive forms, except through the dermal bones of the temporal region. The lower attachment with the basisphenoid I have just shown to exist in Crossopterygians, which are hence "amphistylic," in a different way to Notidanus.

The large teeth on the palatine, with infolded bases, exhibit a curious type of tooth replacement which is

very characteristic of the Stegocephalia, and is unknown elsewhere except in the Crossopterygian fish, where it occurs in a very typical form in the vomerine tusks of *Megalichthys*, and no doubt in many other genera, and in *Lepidosteus*. This occurrence seems to me a strong additional reason for regarding the Tetrapoda as derived from this group of fish.[14]

The lower jaw of "*Loxomma*" likewise approaches the Crossopterygian type in the fact that the splenial is "entirely a bone of the outer side of the jaw as is the first infradentary of the Crossopterygian mandible."

Watson's observations also have important bearing on the relations of the Permian reptilia. These have been distinguished from contemporary Stegocephalians chiefly by the single basi-occipital condyle and by the large pterygoids, which leave only a small interpterygoid vacuity, divided by a narrow parasphenoid. Watson has shown that these and other "reptilian" characters are fully exhibited in "*Loxomma*," *Pteroplax*, *Anthracosaurus* and other Carboniferous Stegocephalians, that these characters they share also with *Megalichthys* and that no palate with large vacuities like that of *Eryops* or *Capitosaurus* has ever been found in Carboniferous rocks. He therefore concludes that "the reptilia were separated off very early in the history of the Stegocephalia, preserving features which were

[10] "Ueber die Saurodipterinen, Dendrodonten, Glyptolepiden und Cheirolepiden des Devonischen Systems," 1860, pls. 1–3.

[11] Cf. Gregory, SCIENCE, N. S., Vol. XXXIII., 1911, p. 509. A figure of this forelimb by Hussakof has recently been published by Dr. Bertram Smith in the *Journal of Morphology*, Vol. 23, No. 3, 1912, p. 544.

[12] Cf. Patten, "The Evolution of the Vertebrates," 1912, p. 391.

[13] "The Larger Coal Measure Amphibia," *Mem. and Proc. Manchester Literary and Philos. Soc.*, Vol. LVII., Part I., No. 1, 1912, pp. 1–14, 1 pl.

[14] *Ibid.*, p. 5.

rapidly lost by the latter group, which had a much accelerated evolution." With this conclusion the trend of recent work on the Permian Tetrapoda by Case, Williston, Moodie and Broom, seems to be in accord.

Wm. K. Gregory

American Museum of Natural History

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 508th regular meeting was held in the assembly hall of the Cosmos Club, February 22, 1913, with President Nelson in the chair and 76 persons present.

The program consisted of a lecture by Edmund Heller on "Hunting with Rainey in Africa." The communication was chiefly descriptive of the maps and numerous lantern slides exhibited and also of the physical features and vegetation of the country as well as the animals secured during the expedition.

The 509th meeting was held March 8, 1913, with Vice-president Paul Bartsch in the chair and 37 persons present.

Under the heading "Brief Notes, etc.," Wm. Palmer exhibited the head of the small devil ray (*Mobula olfersi*) and a plaster cast made from the same, and explained the feeding habits of this fish. A. C. Weed gave some further account of its habits, and Theodore Gill added some historical notes about devil fishes.

Barton W. Evermann reported results of the sale of blue fox skins from the Pribilof Islands at Lampson's (London) auction of March 7. The 384 skins offered sold at an average price of \$56, the highest price being \$85.

The regular program consisted of two communications. J. W. Gidley gave an account of a fossil camel recently found in America north of the Arctic circle. The only bone found was a phalanx. The species was an extinct one and its occurrence so far north was regarded as further proof that there once existed land connection between the continents by way of Alaska. The paper was discussed by Messrs. Wilcox, O. P. Hay, Weed, Gill, Evermann, Lyon and others.

The second communication was by Paul Bartsch on "Some Remarkable Philippine Mollusks obtained by the U. S. Bureau of Fisheries Expedition." Specimens of the mollusks described were exhibited by the speaker.

The 510th meeting was held March 22, 1913, with Vice-president Bartsch in the chair and 50 persons present.

Barton W. Evermann reported the executive order of President Taft made March 3, 1913, setting aside the entire chain of the Aleutian Islands as a wild mammal and bird reservation. The reservation is to be under joint charge of the Departments of Agriculture and of Commerce.

A. D. Hopkins announced the recent organization of a new scientific society, The Society for the Advancement of Forest Entomology in America.

The regular program consisted of two communications:

Recent Progress in the Study and Culture of the Common Eel: Hugh M. Smith.

This was a comprehensive outline of the recent discoveries concerning and the completed life history of the common eel. Statistics of the commercial uses of the eel and the methods employed abroad for its propagation and distribution were given. Numerous lantern slides were shown.

Tree-Shrews: Marcus Lyon, Jr.

This paper was based upon a study of many specimens of these squirrel-like insect-eating animals. Of less than 800 known specimens in museums, the British Museum possesses 355, the U. S. National Museum 24, and about 100 are in other collections. The paper was illustrated by lantern slides. Messrs. Bartsch and Wm. Palmer took part in the discussion.

The 511th meeting was held April 5, 1913, with President Nelson in the chair and 43 persons present.

Under the head of Brief Notes, Paul Bartsch reported observations on the habits of the two common toads of the District of Columbia, *Bufo americanus* and *Bufo fowleri*.

Henry Talbott made some remarks on the probable agency of man in the dispersion of animals during the later geological ages. The regular program consisted of two communications:

A Commercial Aspect of Paleontology: by a Layman: Henry Talbott.

The Zoological Results of the Denmark Expedition to Northeast Greenland: Frits Johansen.

The speaker, who accompanied the expedition, gave an account of climatic conditions and the fauna and flora encountered. Mammals and birds received the principal attention. Maps and numerous lantern slides were used.

D. E. Lantz,
Recording Secretary

SCIENCE

FRIDAY, MAY 30, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE JOSEPH LEIDY LECTURE

INTRODUCTION BY THE PROVOST OF THE UNIVERSITY OF PENNSYLVANIA

JOSEPH LEIDY was a son of the University of Pennsylvania. As a token of reverence and affection his devoted nephew and namesake, Joseph Leidy, Jr., has generously endowed the Joseph Leidy Memorial Lectureship for the extension of scientific knowledge through the medium of lectures by eminent specialists.

To-night, we meet to inaugurate this foundation. Of Dr. Leidy, the great student and teacher, whom many of us knew and deeply honored, I would say:

"The wisest man could ask no more of fate
Than to be simple, modest, manly, true,
Safe from the many, honored by the few;
Nothing to count in world, or church, or state,
But inwardly in secret to be great;
To feel mysterious nature ever new,
To touch, if not to grasp, her endless clue,
And learn by each discovery how to wait,
To widen knowledge and escape the praise;
Wisely to teach because more wise to learn;
To toil for science, not to draw men's gaze,
But for her love of self denial stern;
That such a man could spring from our decays
Fans the soul's nobler faith until it burn."

EDGAR F. SMITH

A TRIBUTE TO JOSEPH LEIDY[1]

JOSEPH LEIDY was a Philadelphian by his birth, by his career and by his death, and no citizen of this metropolis has more deserved public honor than he.

Leidy was born September 9, 1823, and died April 30, 1891. His first scientific paper was published in 1845, and his last

[1] Opening address for the Joseph Leidy Foundation delivered at the University of Pennsylvania, April 17, 1913.

in 1891. For forty-six years he was an active contributor to Science. The list of his publications, prepared by his nephew, gives 597 titles. A large part of these are brief communications to the Academy of Natural Sciences in Philadelphia, but the list includes also a series of articles and memoirs, some of them of considerable extent, and all valuable. Leidy's investigations are among the classics of American science.

He represents a type of scientific man which seems in our days of specialization and of elaborate laboratories almost extinct. He was a naturalist, and was one of the group of four distinguished true naturalists who have done most for the introduction of natural science into American life. These four men—Louis Agassiz, Spencer F. Baird, James D. Dana and Joseph Leidy—were contemporaries. They all took a similar view of nature. She was a whole made up of many parts played together, and they were interested in the whole drama. Their delight was to go forth and see the world and watch the coordinated working of its parts. The correlation between living beings and physical forces appealed to them. They were quite untouched by what we may call the "laboratory spirit," which has arisen since their time—that spirit which isolates an object or phenomenon indoors in order to apply to it all the finest resources of modern scientific equipment. These men, on the contrary, went out of doors to see and study, and the spoils which they brought home were investigated without any elaborate appliances. Young zoologists, botanists and geologists of to-day find these methods too toilsome. In one passage Leidy points out that the studies of the living fauna of our streams and ponds may be carried on by a simple microscope, such as even our elementary students of to-day would scarce deign to use, yet how varied, interesting, and even wonderful the observations which Leidy has recorded! One has only to look through his collected researches in helminthology and parasitology, published by the Smithsonian Institution in 1904, to gain a clear impression of the enormous extent and variety of these observations. He searched all sorts of animals, insects, vertebrates, molluscs and found a great number of parasitic plants and animals, concerning which he reports many original observations. Many of the species discovered were new to science and were named by him. Nearly the whole of the material he studied was collected by himself, for the most part on little trips he made in the neighborhood of Philadelphia. I quote his own quaint reference to these excursions:

> "Going fishing?" How often the question has been asked by acquaintances, as they have met me, with rod and basket, on an excursion after materials for microscopic study. "Yes!" has been the invariable answer, for it saved much detention and explanation; and now, behold! I offer them the results of that fishing. No fish for the stomach, but, as the old French microscopist Joblot observed, "some of the most remarkable fishes that have ever been seen"; and food-fishes for the intellect.

Although professor of anatomy at this university for a long time (1858–1891), his heart was always in his natural-history studies. He did, to be sure, write a textbook of anatomy, undertaken, it is said, only after much urging by the publisher, but it was only an unessential episode in his life. Yet he knew how to use his anatomical opportunities, and he has given us valuable notes on the inter-maxillary bone in man, on the structure of the liver, on reversal of the viscera, etc. But his real life was the exploration of nature. He acquired intimacy not only with animals, the chief objects of his study, but

also with plants, stones and minerals. He collected extensively, his herbarium which he presented to the university contained over 1,500 species, all determined by himself, and his mineralogical collection has been described as "very fine and valuable" and was purchased by the National Museum in Washington. But his chief collections were of animals, especially of such as offered opportunity for microscopical study. The quotation read a few moments ago refers to his gathering of fishes—the particular "fishes" in this case were the Rhizopods. His monograph of this group of unicellular animalcules appeared in 1879 as one of the quarto volumes of the Hayden Survey, and contains a vast amount of original observation and is illustrated by thirty plates, after his own drawings of the living animals. Another extensive work was entitled "Flora and Fauna within Living Animals," one of the most important contributions to parasitology we possess. It was published in 1851 by the Smithsonian Institution in Washington, and is illustrated by ten exquisite copper plates, so skillfully engraved by Oudet that they worthily reproduce the author's beautiful drawings.

The range of work we have already indicated is sufficient to more than occupy an able man, and the results published by Leidy in the field of zoology proper would alone suffice to assure his place among the most distinguished investigators of America. His actual reputation, however, rests at least in equal measure upon his achievements in vertebrate paleontology, which received a richly deserved recognition when the Geological Society of London awarded him in 1884 the Sir Charles Lyell medal. His monographs on American fossil vertebrates laid the foundations of our present knowledge, and first marked out the way by following which Cope and Marsh and their younger successors have attained distinction. Mention may be made especially of the first memoir of the series, "The Ancient Fauna of Nebraska, a Description of Extinct Mammalia and Chelonia from the Mauvaises Terres of Nebraska," published in 1854 in the sixth volume of the Smithsonian Contributions to Knowledge. The wonderful Eocene deposits of the Bad Lands had not been long known, and the collections available had been hardly more than skimmings from the surface. Leidy by the friendly cooperation of the few collectors of the time was able to inspect practically all the remains which had been gathered. The plates are superb lithographs drawn by the talented Sonrel. In 1855 followed the memoir on the Sloths, in 1865 on the Cretaceous reptiles, and other memoirs in later years (1869, 1873 and 1877).

A special extraneous interest attaches to Leidy's paper on the extinct sloths, for it includes a careful description of *Megalonyx Jeffersoni*, the first remains of which were discovered in Virginia and were described by no less a person than Thomas Jefferson at a meeting of the American Philosophical Society on March 10, 1797. The bones were soon after identified by Dr. Caspar Wistar as not those of a carnivore, as thought by Jefferson, but of a sloth. Casts of these bones were sent to Cuvier, who studied them. I am told that the originals, collected by Jefferson, are now in the collection of the Academy of Natural Sciences in this city.

It happened that the study of vertebrate paleontology in the seventies and eighties of the last century was pursued with great zeal, but also unfortunately with certain rivalries, which aroused acrimonious feelings, too often publicly expressed. Leidy shrank from controversy and it is said that rather than risk being entangled in dis-

putes, so little to his taste, he withdrew from paleontological work altogether.

Leidy was a student of facts, a lover of positive knowledge. His attitude is indicated by the following words from the preface to his article on the extinct mammalia of Dakota (1869):

> The present work is a record of facts. . . . No attempt has been made at generalizations or theories which might attract the momentary attention or admiration of the scientific community.

Note the implied scorn of hasty speculation, and remember that in 1869 most biologists had been carried off their feet by the whirlwind of speculation which arose in the wake of the Darwinian theory. Leidy remained undisturbed, a firm devotee of objective research.

Leidy's connection with the Philadelphia Academy of Natural Sciences was long and intimate. His earliest publication known to me was a communication to the academy in 1845. Two years later he became chairman of the board of curators; the collections of the academy long profited by his devotion and wide knowledge of natural history. From 1881 until his death he was president.

For nearly fifty years Leidy was a constant attendant at the meetings of the Philadelphia Academy and very often had matters of interest to communicate, many of which are briefly recorded in the *Proceedings*. Sixty years ago the meetings of local scientific societies had an importance and a charm, which have been much diminished by the developments of the last twenty-five years. A generation ago there were fewer specialists, and narrow interests did not dominate the majority of scientific workers as much as to-day. When naturalists met they spoke a common language, and were mutually interested in one another's discoveries—sixty years ago. There were no national special societies, and no express trains to bring the members together for three days, and to scatter them asunder for three hundred and sixty-two days—sixty years ago. The knowledge of the individual was less intensive, but his outlook was broader—sixty years ago. To this old order—now passed forever—Leidy belonged. The range of his interests and of his contributions, as revealed by a careful study of the *Proceedings of the Academy of Natural Sciences*, is astonishing, if viewed from the standpoint of cotemporary specialization. There are statements in his usually brief notes in the *Proceedings* concerning regeneration in Planarians, the formation of the cell wall *after* the division of the cells, on the occurrence of internal parasitic plants in various animals, on bacteria in the intestine of toads, the sense of smell in snails, on a new fossil, on the structure of cartilage, parasitic worms, sponges, Infusoria, Rotifera, Annelids, extinct reptiles, fishes, parasitic Hymenoptera—all incidental and in part accidental observations, but reported with unfailing accuracy.

It should be recorded that time has greatly emphasized the importance of some of Leidy's original discoveries, as of the existence of a bacterial flora in the intestine (1849). Particularly noteworthy are his experiments with cancer, made in 1851.[2] He transplanted small fragments of a human cancer under the skin of a frog and found that they maintained themselves for a long period. At the close of the communication, the author says:

> The experiment not only proved the independent vitality of the tissues, which was generally admitted, but also rendered it extremely probable that cancer was inoculable, for, as in the experiments, the cancerous fragments continued to live when introduced into cold-blooded animals, they

[2] *Proceedings Acad. Nat. Sci., Philadelphia*, V., p. 212.

would probably not only continue to live when introduced into warm-blooded animals, but would grow or increase in size.

The transplantation of tumors has become an important method of pathological research. We should not forget that Leidy originated the method.

Leidy's supreme gift was the ability to see, coupled with an inexhaustible delight in seeing. He saw so well not only with his eye, but with his intelligence and interpreting mind, that his published observations maintain a level of accuracy to which few naturalists have risen. His characteristic accuracy shows equally in his brief notes and in his extended monographs—it seems never to have failed. Dr. Thomas G. Lee says of Leidy's publications that they "probably contain fewer errors of fact and interpretation than those of any other writer on so many and such varied subjects." The joy of seeing is an inborn gift. It manifested itself very early in Leidy and was accompanied by a talent for drawing. This talent was so marked in the boy that his father withdrew him from school when he was sixteen, with the idea of educating him as an artist. But at this age he was already a naturalist, a student of nature by spontaneous instinct. He dissected cats, chickens and other animals and showed such intense interest in comparative anatomy that it was decided that the lad should study medicine. He attended lectures on medicine at the University of Pennsylvania and obtained the degree of doctor of medicine in 1844, and for two years actually practised. In 1846 he was demonstrator of anatomy in Franklin Medical College, and in 1847 he became a teacher in the university under Dr. Horner. In 1850 he had the great advantage of a trip to Europe with Dr. George B. Wood, to collect material to illustrate Dr. Wood's lectures. It gave the young naturalist fresh stimulus, for he made the acquaintance of a number of famous anatomists and physiologists. The late Mr. Isaac Hinckley was fond of relating how Dr. Wood found it difficult to persuade Leidy to overcome his modesty so far as to send in his card also to Johannes Müller. Presently Müller came into the room, crying out, "Which is Leidy?" Extreme modesty was a marked characteristic of Joseph Leidy throughout his life, and was accompanied by an amiable unselfishness, which endeared him alike to his friends and his students. In 1858, after the death of Dr. Horner, Leidy was made professor of anatomy in the university and continued to fill the chair until his own death, thirty-three years later.

Leidy's death terminated the career of a man whose noble and unflagging devotion to science secured a rich harvest of discovery. He has left a message to us which I deliver to you in his own words:

> The study of natural history in the leisure of my life, since I was fourteen years of age, has been to me a constant source of happiness; and my experience of it is such that independently of its higher merits, I warmly recommend it as a pastime, which I believe no other can excel. At the same time, in observing the modes of life of those around me it has been a matter of unceasing regret that so few, so very few, people give attention to intellectual pursuits of any kind. In the incessant and necessary struggle for bread we repeatedly hear the expression that "man shall not live by bread alone," and yet it remains unappreciated by the mass of even so-called enlightened humanity. In common with all other animals, the engrossing care of man is food for the stomach, while intellectual food too often remains unknown, is disregarded or rejected.

It is an honor to Philadelphia that the statue of Joseph Leidy stands by the great city hall. It is an honor to the University of Pennsylvania that his name is to be from this evening forth associated with the university's highest work. We are gath-

ered here to express our reverence for the man and our admiration for the scholar. It is our part to keep alive the tradition of truth-loving, of scientific devotion and of perfect modesty which is our legacy from Joseph Leidy.

CHARLES S. MINOT

HEREDITY AND MICROSCOPICAL RESEARCH[1]

I have been much honored by the invitation to deliver the first lecture of a series established in honor of Joseph Leidy, a man distinguished alike for the diversity and importance of his original contributions to knowledge and for the far-reaching influence that he exerted on other men of science, in his own time and after. No American naturalist could be named whose biological interests ranged over a wider field; and the selection of my topic this evening has been influenced in some measure by the fact that Leidy was an almost solitary pioneer of microscopical investigation in this country, at a time when the cell-theory was in the earliest stages of its development, and when no one could have imagined the brilliant future that lay before it. Did time permit I would gladly dwell for a moment on his early observations on the structure and division of cells, and on the activities of the simplest forms of life. Much of his subsequent work lay in a very different field of inquiry, but his interest in microscopical investigation never deserted him, witness to which was borne by the publication in his later life of a beautiful monograph on the fresh-water rhizopods, which at once took its place as one of the classics of American zoology.

[1] A lecture delivered before the University of Pennsylvania, April 17, 1913, on the Joseph Leidy Foundation. With the exception of three general diagrams it has been impracticable to reproduce the figures that were shown by means of lantern slides.

More than half a century has passed since Leidy's earliest studies with the microscope. The main motive power behind the unparalleled advance in biology during this period has been the persistent effort to explain the activities of living things through investigations upon their structure, whether anatomical, physical or chemical. This effort entered upon a new era with the discovery of protoplasm and the promulgation of the cell-theory; for its final objective was now seen to lie in minute structural elements, the cells, of which the tissues are composed. Little by little it became clear that the cell, whatever else it be, is a microscopic chemical engine, where the energy of the foodstuffs is finally set free, and applied to the work of life. The question inevitably arose whether we can discover within the cell any visible apparatus by which this is accomplished. The inquiry has a thousand aspects; I ask your attention to that which relates to the problem of heredity.

It long since became clear that the cell-theory offers us a general explanation of heredity. Heredity is a consequence of the genetic continuity of cells by division, and the germ-cells form the vehicle of transmission from one generation to another. This fundamental discovery divested heredity of the mystery in which it had so long been enveloped, though it must always remain among the most wonderful of phenomena. But this result only cleared the way for further advances. Our scientific curiosity is aroused in the highest degree by more specific problems of heredity. Why do individuals now and then appear that show little resemblance to their immediate progenitors but "revert" to much more remote ancestors? Why do the grandparents often exert definite effects upon their grandchildren of which no suggestion is given by their children? What

explanation can be offered of the combinations and recombinations of parental or grandparental characters that appear in definite numerical proportions in hybrids? We may glance at a few particular cases that will serve to place some of these questions before you in more concrete form. In the first view we see the results of crossing two distinct races of sweet peas, each of which is pure white and produces only white offspring so long as strictly inbred. On crossing the two races the hybrids are always deep purple, like the wild Sicilian species, and in this respect they no doubt revert to an early common purple ancestor of the two white races. The offspring of the hybrids include a variety of purple, red and white forms, among which are whites that are identical with the two original grandparents. Here is a somewhat similar case in domestic fowls. You see two different white races, each of which breeds true; but when crossed together they produce deeply colored hybrids, showing a pattern of plumage that is closely similar to that of the wild jungle fowl from which both white races are probably descended. How is the reversion shown in this and the preceding case to be explained?

Let us look at some more complicated phenomena. We have here the result of crossing two differently colored races of fowls, the barred Plymouth Rock and the black Langshan. If the barred cock be paired with the black hen, all the offspring are barred, like the father. If the barred hybrids be paired together the progeny includes, on the average, three barred to one black, and the black bird *is always a female*. Quite different, and even more singular, is the reverse cross shown in the next view, where the black cock is paired with the barred hen. Half the offspring are now barred and half black; and the remarkable fact is that the barred birds are all males, the black ones all females. In color pattern the sons are like their mother, the daughters like their father—an example of the so-called "criss-cross" heredity. Upon pairing these hybrids together, the following generation (grandchildren of the original forms) includes males and females of both types, barred and black. In the following view we see a quite analogous form of heredity, observed by Morgan in crossing a long-winged and a short-winged race of fruit-flies (*Drosophila*). When the male of a long-winged race is paired with the female of a short-winged race, all the sons are short-winged like their mother, all the daughters long-winged like their father. On pairing these two, the offspring are of all four types, long wings and short wings occurring in both males and females.

Such results seem at first sight capricious, almost fantastic, but this first impression is erroneous. The results are not capricious, but constant. The experiments may be performed over and over again, always with the same result, so that the outcome may be unfailingly predicted in advance; and this demonstrates that such forms of heredity, and heredity in general, must be due to some definite apparatus in the germ-cells. I shall try to show that microscopical research has revealed to us at least something of the nature of this mechanism, and that it has practically solved some of the very puzzles that have just been propounded. In order to indicate the nature of this solution, I must first ask attention for a moment to the so-called "unit-characters" and their behavior in heredity, on which the attention of both cytologists and experimenters on heredity has been largely concentrated in recent years.

Unit-characters have become too familiar to require more than brief illustra-

tion. Examples of them have just been seen in the colors of flowers or of plumage, and in the structure of the wings in flies. Their interest lies especially in the fact that they are transmitted independently of one another, as if they were separate and independent things. By appropriate crossing experiments, such as we have just seen, particular groups of such characters may be split up and recombined, over and over again, in constantly new combinations, with no alteration of their individual character. Let us look at one or two examples of this. Here are the results of crossing two different races of wheat (from experiments by Biffen). One parent is a bearded variety with short, dense heads; the other a beardless form with long, loose heads. The hybrid is intermediate in shape, and is beardless. On pairing the hybrids together all combinations of the four original characters, and of the hybrid character, appear in the grandchildren, namely, (1) short beardless, (2) short bearded, (3) hybrid bearded, (4) hybrid beardless, (5) long bearded and (6) long beardless. These six types appear in definite numerical ratios, and it is evident that the bearded or beardless character has been transmitted quite independently of the shape of the head.

Another and very striking case of the same kind is here seen, again from Morgan's experiments on fruit-flies. The grandfather has white eyes and yellow body color; the grandmother red eyes and gray body color. In the first generation all the offspring have red eyes and gray color. Among the grandchildren, however, appear not only both the original combinations but two new ones, namely, white-eyed grays and red-eyed yellows. Here again the second generation of hybrids shows all possible combinations of the four original unit-characters, white eye, red eye, yellow color and gray color. With a larger number of unit-characters the same would hold true, but the number of combinations would be much larger.

We catch a glimpse here of the methods by which the modern breeder of plants or animals is able to break up known combinations and recombine them into new types, somewhat as the organic chemist splits up known organic compounds and recombines the products into new compounds, perhaps unknown before. Our ability to do this is often of high practical value. As de Vries has said, most hybrids owe their character to a new combination of qualities. "It is the combination that is new," he says, "not the qualities themselves. Some characters are derived from one parent, others from the other. Each of these may be simply inherited, . . . but by their new combinations they yield varieties of higher practical value, and notable examples are afforded in those cases where one parent has contributed vigor of growth, hardiness in winter, resistance to disease or productivity, and the other bright flowers, palatable fruit or nutritive seeds." An example of this which he cites is Luther Burbank's celebrated white blackberry, produced synthetically by uniting in one race the light color of the fruit of an inferior variety of cultivated bramble with the large and succulent fruit of the Lawton blackberry. Another familiar example, also cited from Burbank's work, is the so-called Shasta daisy, which unites the desirable qualities of plants from three different continents. An English daisy has contributed its large flowers and tall, stiff stems; a Japanese species its whiteness of bloom; an American field daisy its profusion of flowers and hardiness in winter. Many other examples might be given to illustrate how by dissociation, recombination and selection desirable qualities may be brought together and undesirable ones eliminated; and by

this principle the improvement of domestic races of plants and animals is being attempted in many parts of the world to-day.

Now, it is obvious that we should be able to understand the behavior of unit-characters, at least in some degree, if it could be shown that they are somehow dependent individually upon separate structural elements or different chemical substances that may be separately transmitted through the germ-cells. It is just this which microscopical research and experimental researches on heredity, taken together, have demonstrated. They have accomplished more than this. They have not only shown with a high degree of probability how the transmission of unit-characters is effected, but have thrown at least some light on the question how the splitting up and recombination of particular groups of such characters takes place. The main part played by microscopical research has been to bring forward proof that the hereditary characters are somehow connected with separate bodies, contained in or formed from the cell-nucleus, and known as the *chromosomes*. Besides the chromosomes the cell also contains another kind of bodies found in the cell-protoplasm, and known as *chondriosomes* or *plastosomes*. These too are very likely connected with heredity; but their true significance has not yet become very clear, and we shall hardly have time to consider them within the limits of this address.

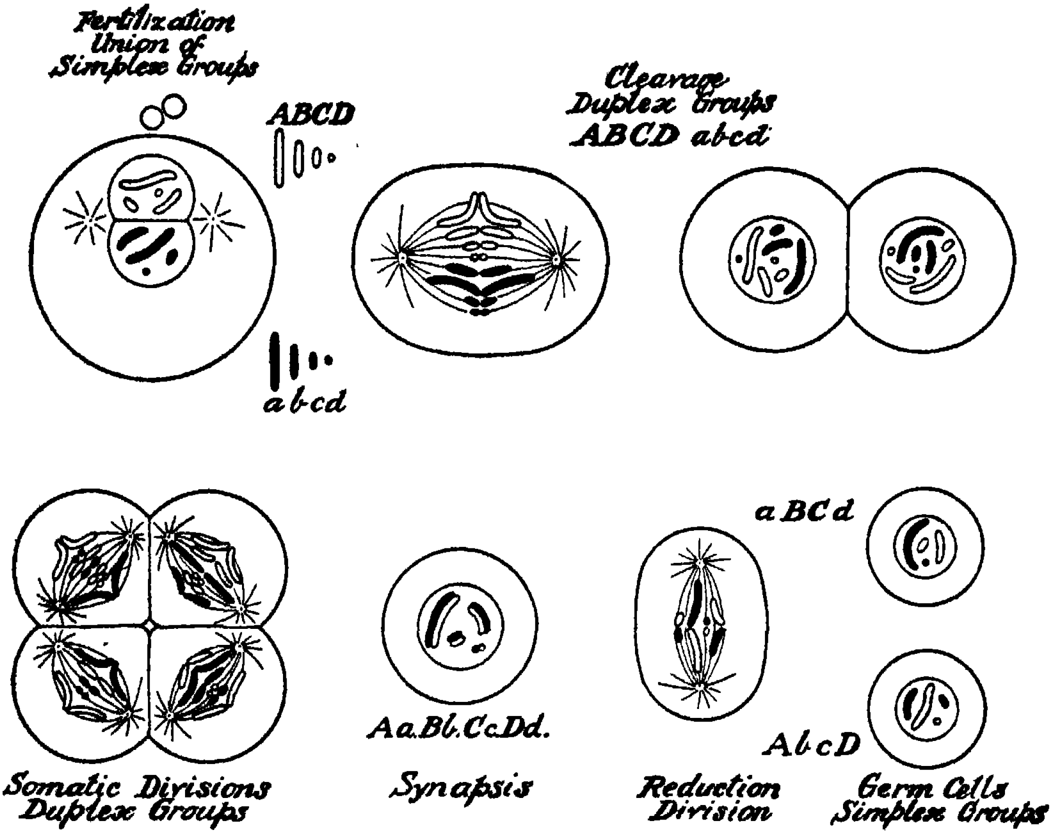

FIG. 1

With the aid of the accompanying diagram (Fig. 1) we may consider a few ea-

sential facts concerning the chromosomes, leaving aside most of the complicated technical details. In each species of plant or animal the chromosomes are of constant, or nearly constant, number. They divide as the cell divides, and are thus transmitted from cell to cell. In the fertilization of the egg two similar groups of chromosomes are brought together, one contributed by the egg, one by the sperm-cell; and as the egg step by step divides to build up the body of the embryo the chromosomes also divide at each cell-division. Every cell-nucleus thus receives a double group of chromosomes, consisting of two single groups descended respectively from the two groups that originally came together in the fertilized egg. The two single groups of each nucleus are thus of maternal and of paternal ancestry, respectively. This all-important conclusion has been obstinately contested and is still denied by a few writers. I think, however, that all arguments against it must give way before the fact that in certain hybrids—in particular, certain fish-hybrids observed by Moenkhaus—the chromosomes of maternal ancestry can actually be distinguished by the eye from those of paternal. Finally, when new germ-cells are produced for the formation of the following generation the double chromosome-groups are again reduced to single ones in preparation for the succeeding process of fertilization.

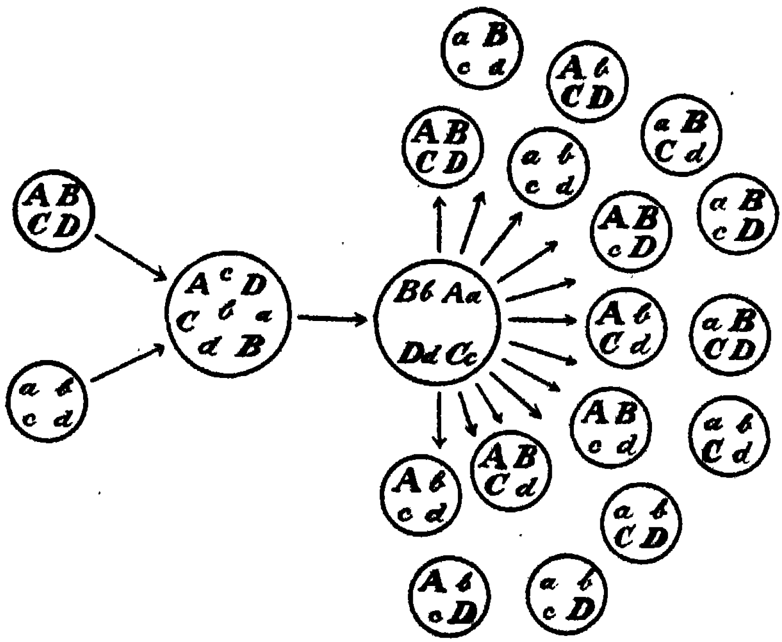

FIG. 2

These are not theories but observed facts. It is impossible to overlook the very precise parallel which they show to what Gregor Mendel and his successors have proved to be true also of the unit-characters, as will be made clear by the accompanying diagram (Fig. 2). When two similar or nearly similar individuals unite in fertilization they contribute to the germ two corresponding groups of unit-characters, which are designated in the diagram by two series of letters A–D and a–d, respectively. The

offspring are therefore of double or "duplex" hereditary constitution. When the germ-cells are formed, as Mendel first proved by experiments on hybrids, they are found to carry only a single or "simplex" group of characters. So closely parallel is all this to what we have learned about the chromosomes that we can just as well use the diagram for the chromosomes as for the characters. Chromosomes and characters alike form a single or simplex group in the germ-cells, a double or duplex group in the body of the offspring; and this alone is sufficient to make it extremely probable that chromosomes and characters are somehow connected. Exactly what is the nature of this connection we are not able to say with certainty; but we might reasonably assume, for instance, that each character depends upon some particular chemical substance, or group of substances, contained in the chromosomes, and that different chromosomes differ in respect to the substances which they carry. Such an assumption would be thoroughly in accord with the principles of chemical physiology and with the results of experiments upon the physiology of development.

The diagram brings out another fundamentally important fact that was also proved by Mendel's experiments, namely, that in the formation of the simplex character-groups all possible recombinations of the original parental unit-characters (within the limits of a single complete group) are effected. Only a few of the germ-cells receive the original combinations unchanged (A–D or a–d). In most cases new simplex groups are formed by recombination, such that each germ-cell receives always a complete single series (from A or a to D or d), but any particular member of the series may be derived from either parent. The number of such possible combinations varies, of course, with the simplex number of unit characters; with 4 characters, as in the present case, it is 16; with 15 characters it would be more than thirty thousand. Any individual may thus produce many different kinds of germ-cells, equivalent in a general way but differing slightly in respect to their individual hereditary components. This result follows from the fact, discovered by Mendel again, that corresponding or homologous parental components of the duplex groups (such as A and a, or B and b) never enter the same germ-cell; and this is the essential fact in "Mendel's Law." We could readily understand this if before the germ-cells are formed corresponding parental components become associated in pairs (Aa, Bb, etc.) and then separated or disjoined in an ensuing process of division. If the process of disjunction took place in each pair independently of the others, all combinations would obviously be produced in the resulting germ-cells. Now, it is certain that something like this actually takes place in the case of the chromosomes. In the process known as *synapsis*, which takes place shortly before the last two cell-divisions concerned in the formation of the germ-cells, the chromosomes do in fact unite in pairs, two by two. There is reason to believe that the two members of each pair are respectively of maternal and paternal derivation; and the probability of this view, first stated by Montgomery, has steadily increased. Observation has made it extremely probable that in the course of the following two divisions the two members of each pair, or two somethings that they contain, are separated so as to pass into different germ-cells (Fig. 1). One of the most interesting recent discoveries in cytology is the fact that in some animals and plants a paired arrangement of the chromosomes is assumed long before the period

of synapsis, and may even be seen more or less distinctly throughout the life of the organism.

As has been said, the remarkable parallel between chromosomes and unit-characters constitutes in itself strong (though indirect) evidence that the latter depend in some way upon the former. Specific experimental evidence directly demonstrates the correctness of this conclusion. If, for instance, the orderly distribution of the chromosomes in the fertilized egg is artificially interfered with (as may be done in several ways) the development of the embryo is correspondingly disturbed. Boveri has proved that when abnormal combinations of the chromosomes are thus produced in the fertilized eggs of sea-urchins the offspring are almost always abnormal, deformed or monstrous. Recent experimental studies have proved by various methods that certain interesting abnormalities shown in hybrids are preceded by corresponding disturbances in the chromosomes. Again, it is now possible to fertilize the eggs of such animals as sea-urchins by the spermatozoa of animals as widely different as worms or mollusks. The offspring of such "heterogeneous" crosses show only the characters of the mother. They are typical sea-urchin larvæ; and the explanation, demonstrated by microscopical observation, is that only the chromosomes of the mother are able to survive in the fertilized egg. Those of the foreign father (*i. e.*, of the sperm cell) sooner or later perish and degenerate within the egg.

Still another fact, of the same unmistakable import, is the recently demonstrated relation between the chromosomes and sex. Sex is now definitely known to be inherited like other characters; and within a few years the decisive proof has been attained that the heredity of sex is connected with a particular chromosome known as the "sex-chromosome" or "X-chromosome." In a large class of cases, to which man almost certainly belongs, the male contains but one of these chromosomes, the female two; hence in such cases the total number of chromosomes in the female is one greater than in the male. In respect to these particular chromosomes, accordingly, the male always remains of simplex composition (XO), while the female is of duplex (XX). Observation has proved further than when the duplex chromosome-group of the female are reduced to simplex ones each mature egg retains a single X-chromosome, while in the male only half the spermatozoa receive X and half do not. From this it follows that when the egg (X) is fertilized by a sperm-cell containing X the result is a female (XX), while if fertilized by a sperm-cell without X, the result is a male (XO). I shall try to show a little later how clearly and simply these facts explain certain very curious special phenomena connected with the heredity of sex.

The specific and direct evidence thus briefly outlined has definitely established the fact that the chromosomes are causal agents in heredity; and it has already become evident that the study of their modes of distribution, combination and recombination provides us with a key which will unlock many special puzzles of heredity which would otherwise seem to us insoluble. I will attempt to make this clear in greater detail by considering three of the particular cases that have already been touched upon, taking them up in the order of their difficulty.

The simplest of these cases is that of reversion, illustrated by the sweet peas. It is evident from the experimental results that the purple color of the flowers requires the cooperation of at least two things, either of which alone is unable to produce

any color. These two things may for the moment be called "A" and "B." Both A and B must obviously have been present in the original purple race from which the two white races are descended. One race has at some time in its past history lost A, the other B; and each loss has produced a specific type of white race which breeds true. By crossing the two A and B are again brought together, thus restoring the original combination AB; hence the "reversion" to the purple wild type. Now, the things which we have called "A" and "B" may very well be different chemical substances. If we assume them to be borne by different chromosomes, brought together in the hybrid, the whole matter becomes at once clear and simple. It seems probable that all kinds of reversion may be explained by the same principle.

The second case is that of "criss-cross" heredity in the short- and long-winged flies, where the sons are like their mother, the daughters like their father. The explanation of this case is less easy to follow than that of reversion, but is more specific. This case, and many others of similar type, may be completely explained through our knowledge of the relation of the chromosomes to sex. These flies agree with the general rule already referred to, that the males contain a single X-chromosome, or sex-chromosome, the females two. All the facts revealed by experiment are very simply and completely accounted for by the single assumption that the X-chromosome is responsible not only for sex, but also for the short-winged character. Specifically, the assumption is that the short wings are due to the lack or defect of something (let us again say some definite chemical substance) that is contained in the X-chromosome. Let us see just how this works out. We may write the formula for the short-winged female as xx (the small letters indicating the defect in X that is responsible for defective wing development), while that of the normal (long-winged) male is XO. Such a female produces eggs of only one type, x, while the normal male produces sperms of the two types X and no X or O. Fertilization thus can only give rise to the two combinations xX and xO, the former being females, the latter males. The males are short-winged because they contain only the defective x. The females likewise contain such an x, but they are nevertheless long-winged because they also contain a normal X, which is sufficient to ensure normal wing development. It follows that the daughters are long-winged like their father, the sons short-winged like their mother. I need not trace this explanation further into its details. It is enough to say that upon this one assumption the results of many other kinds of crosses among these flies work out perfectly; and a similar explanation will completely account for other cases of criss-cross fertilization, for such curious phenomena as the heredity of color-blindness in man, and many other cases in which particular somatic characters are linked with sex in a definite way. These cases offer, indeed, a brilliant example of the clearness and simplicity of the causal explanations that microscopical research has helped to give of complicated special phenomena of heredity.

As a third and last example I select an even more interesting and instructive case, the complete analysis of which carries us to the firing line of research in this field. It illustrates the influence of the grandparents upon the combinations of unit-characters seen in the grandchildren. It is a very curious fact, only recently discovered, that in certain cases hybrids of identical composition exhibit marked differences in their output of offspring that can

only be explained by an exact knowledge of the grandparents. We have already seen a concrete example of this; but before returning to it the essential result may be explained by means of a diagram. Let us consider the case of a hybrid that contains four characters, which we will designate as A, a, B and b. The hybrid AaBb can be made in two ways, according to the composition of the parents. First, one parent may contribute AB and the other ab; or, secondly, one parent may contribute Ab and the other aB. These two crosses seem to give precisely the same result, AaBb. The hybrids produced by the two methods look exactly alike; they produce the same kind of offspring (grandchildren of the original forms). The remarkable fact is, however, that in some cases (probably in many) the offspring of the two kinds of hybrids differ in respect to the numerical proportions in which different combinations of the grandparental characters appear. In both cases the grandchildren are of four visibly different types, AB, aB, Ab and ab. Following the first cross, however (AB $\times$ ab), the classes AB and ab are in great excess among the grandchildren, sometimes in very great excess; while following the second cross (Ab $\times$ aB) it is the classes Ab and aB that are in excess. In other words, in each case a large majority of the grandchildren are of the same type as their grandparents, while a small minority show new combinations of the grandparental characters. To change the statement, if A and B enter the hybrid together they tend to come out together in the grandchildren; if they enter separately they tend to come out separately. Why should this be so?

The facts will become clearer if we look again at the actual case of the fruit-flies already referred to, which was worked out by Professor Morgan. The grandfather combines white eyes and yellow body color; the grandmother red eyes and gray color. White eyes and yellow color here enter the hybrid together, while white eyes and gray color, or red eyes and yellow color enter separately. The hybrids in the first generation all show red eyes and gray color, like the mother. On pairing the hybrids together, all four combinations appear—red eye and gray color, white eye and yellow color, white eye and gray color and red eye and yellow. The last three of these are *seen* only among the males; for although also present among the females they do not come into actual view, because in this sex white eye or yellow color is dominated or concealed by red eye or gray color. We may therefore confine our attention to the males. Now, on counting the relative numbers of these types among the grandsons a remarkable result constantly appears. An enormous majority of them—more than 100 to 1—show the same combinations as the grandparents, namely, white eye and yellow color, or red eye and gray color; while the two new combinations, white eye and gray color, and red eye and yellow color, are correspondingly rare. This, I repeat, is obviously because the characters that enter the hybrid together tend to come out together in the grandchildren; those that enter separately tend to come out separately. This at once suggests that the difference of result depends upon whether the two characters in question are borne by a common carrier in the germ-cells or by different carriers. White eye and yellow color tend to hold together because they enter the hybrid in some common carrier. White eye and gray color, or red eye and yellow color tend to remain separate because they enter the hybrid in different carriers. What are these carriers? Very extended experiments, analogous to that just de-

scribed, and involving the breeding of many thousands of these flies, have steadily increased the probability that these carriers are nothing other than the chromosomes. These experiments make it almost certain that in the cross we have been considering white eyes and yellow color are alike determined by the same chromosome, while red eyes and yellow color must obviously have been carried originally by different chromosomes, since they came from different grandparents.

There is here, as in the case of the short-winged flies, almost conclusive proof that a single chromosome may be responsible for the heredity of more than one character; and experiments of the same type have proved that a single chromosome may be responsible for many characters—at least twenty, and probably many more. Independent microscopical investigation has provided a very definite basis for this conclusion, having made it almost certain that the chromosome is a compound body, which includes many smaller elements, perhaps different chemical substances, each of which may play a definite part in determination. Both kinds of evidence indicate that these different elements are arranged in the chromosomes in linear series and in a definite way. The chromosomes arise from long threads, which split lengthwise throughout their whole length during division. In this way all the separate elements or substances which they contain may be equally divided and distributed to the daughter cells.

And this leads us finally to one more point that now forms a center of interest in these studies. Although (in such cases as we have been considering) characters that enter the hybrid together tend to come out together in the grandchildren, they do not always do so. As we have seen, in a few of the grandchildren characters that were originally associated have separated so as to produce new combinations—such, for example, as the white-eyed gray flies, or the red-eyed yellows. How can this be reconciled with the conclusion that they were originally borne by the same chromosome? A possible answer to this question has been offered by Janssens's theory of the "chiasmatype," which has been more specifically and very ingeniously worked out by Morgan and some of his pupils. Reference has already been made to the fact that at a certain period, shortly before the germ-cells are formed, corresponding maternal and paternal chromosomes become coupled in pairs, side by side (synapsis). This process is always followed by a more or less intimate union of the two threads, perhaps in some cases by actual fusion. The evidence is still more or less conflicting as to exactly what follows; but it is certain that at a later period two separate and parallel threads again become distinct, and these *may* separate so as to pass unchanged into different germ-cells. These two threads are believed by many observers to be identical with those that originally united in synapsis, but this is in dispute. The fact of particular interest in this connection is that the two threads often become twisted around each other like the strands of a rope; and the observations of Janssens indicate that in some cases these threads may fuse at certain points where they cross and then split apart at these points in the longitudinal plane. By this process, as will be made clear by the accompanying diagram (Fig. 3), the possibility is given of an *orderly* exchange of certain regions of the threads between the two chromosomes of each pair. Now, it has been suggested that in this way two chromosomes that originally carry (let us say) AB and ab, may undergo such an exchange as to produce the new chromo-

somes Ab and aB, as shown in the upper part of the diagram. If this should happen only occasionally it would fully explain how it is that two characters borne by the same chromosome tend to remain together, yet *may* separate so as to pass into different chromosomes and hence into different germ-cells. As shown in the lower part of the diagram, a similar explanation may be extended to much larger series of characters, the behavior of which in detail may depend upon their arrangement in the threads, or on the character of the twisting. On the basis of this hypothesis an attempt has recently been made by Sturtevant to calculate from the observed results the degree and character of the twisting of the chromosomes, and the relative position of the different specific elements within them. This, admittedly, is a bold venture into a highly hypothetical region. Its justification is the pragmatic one that it "works." The hypothesis gives us the only intelligible explanation that has yet been offered of a series of undoubted facts; and it is certainly worthy of the most attentive further examination.

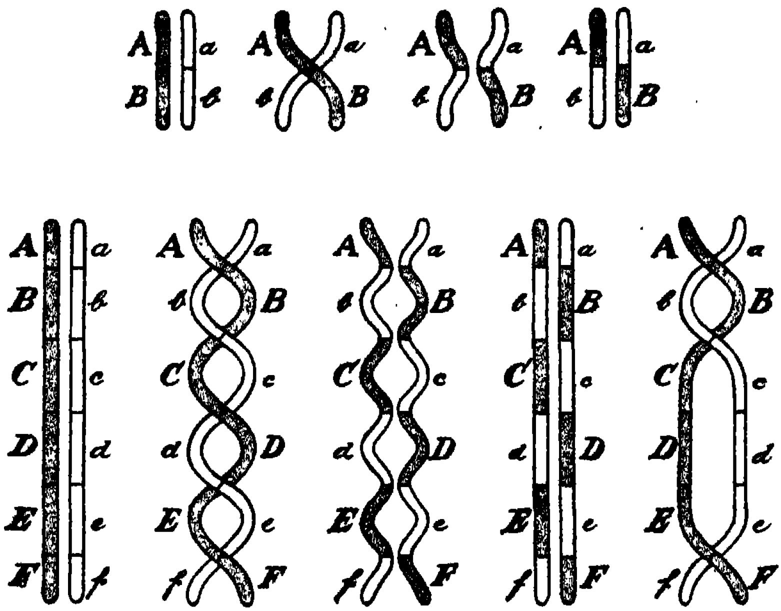

Fig. 3

The three cases that have been considered have led us, step by step, to the border line of research in this field. I have not hesitated, in discussing the last case, to advance beyond the solid ground of observed fact into a debatable and hypothetical region; for it is by just such venturesome advances that new possibilities of discovery are opened. We have much to gain and nothing to lose by the use of explanatory hypotheses that are naturally suggested by the facts and help us to formulate them for analysis, so long as such hypotheses are not allowed to degenerate into dogmas accepted as an act of faith, but are only used as instruments for further observation and experiment. The "chiasmatype" hypothesis is no more than this; and though it is directly suggested by observed facts it remains for the present unproved. The more general conclusions that have been indi-

cated regarding the chromosomes stand, however, upon much firmer ground. That the chromosomes are in fact causal agents in determination can now be doubted, so I think, only by those who refuse to reckon squarely with the whole body of evidence. That the distribution of the chromosomes, or of smaller elements that they contain, gives us at least a partial explanation of the behavior of unit-characters has become in a high degree probable. The stubbornness with which each step in the establishment of these conclusions has been contested has been largely due, I think, to a misapprehension for which the advocates of the chromosome-theory are themselves in part responsible. The chromosomes have often been spoken of as if they were central, controlling factors in heredity, or as if they were actual bearers of the unit-characters—the latter form of expression has in fact been employed, for the sake of brevity, in the foregoing discussion. But it seems to me that such expressions are, to say the least, misleading; they are certainly unnecessary. It is perfectly obvious that chromosomes do not bear hereditary characters as such; they bear only *somethings* that are necessary to the production of characters. I again repeat that these "somethings" may be at bottom of chemical nature. We find it convenient, in order to avoid circumlocution, to speak of these things or substances as "determiners"; and there is no objection to doing this so long as we do not forget that many other things are concerned in the production of every character. Experiment has made it certain that the cell protoplasm is thus concerned. It is possible that the chondriosomes or plastosomes may here play an important part. In any case, the conclusion is not to be escaped, I think, that the whole cell-system is directly or indirectly involved in the production of every hereditary trait. To treat the chromosomes as if they were central governing or controlling factors in the cell is a procedure of more than doubtful expediency. For the present, at least, all the requirements of investigation are sufficiently met if we think of the chromosomes, or that which they carry, only as *differential factors* in heredity, not as its primary or exclusive "determiners." Whether they possess a significance more fundamental than this is a question that may well await the results of further inquiry.

I can refer here to only one or two of the many disputed questions of detail regarding the chromosomes. One of the most important is whether the chromosomes retain their individuality intact in the nuclei of the "resting period" or interkinesis that intervenes between successive cell-divisions. Some of the most careful recent cytological studies in this direction seem to show that such is not the case. Nevertheless these same studies, together with recent experimental evidence, give very strong ground for the conclusion that a definite relation of genetic continuity exists between the individual chromosomes of successive generations of cells. On the one hand, the cytological studies of Boveri, Bonnevie, Vejdovsky and others, almost conclusively prove in certain cases that each chromosome is formed directly from the substance of a corresponding chromosome in the preceding generation. On the other hand, cytological and experimental evidence combine to show that alterations of the chromosome-groups, involving the addition to or subtraction from the group of one or more *particular chromosomes*, are perpetuated generation after generation of cells, even throughout the life of the individual. Nature performs such an experiment every day in the production of sex; for the particular chromosome-com-

binations established by the entrance into the eggs of spermatozoa with or without the X-chromosome persist throughout the whole development of the individual until new germ-cells are formed.

A second fundamentally important question, concerning which no general consensus of cytologists has yet been reached, relates to the mode of union of the chromosomes in synapsis and the subsequent distribution of their substance to the germ-cells. Only in a few special cases has complete proof been attained of a conjugation followed by complete disjunction or separation of the original conjugating chromosomes. Until this complicated and difficult problem has been much more thoroughly studied we shall not be in a position to explain exactly what is the mechanism of Mendel's law of heredity and the distribution of the unit-factors to the germ-cells. We are not dealing with a closed chapter in the study of heredity. Both genetic and microscopical research are still in a formative stage. It is hardly a decade since they finally converged upon the same specific problems. We must not yet make too exacting a demand upon the explanatory capacity of either; and it is a part of the present interest of the subject that so much still remains to be accomplished.

We have thus arrived at some of the most advanced and difficult questions in this field of inquiry. Perhaps I have not succeeded in making entirely clear even the few illustrative cases that have been considered. If so, I must plead in extenuation that the subject is beset with technical difficulties; and we biological folk have come to speak a language that is strange to many of our fellows. But I have been less concerned with the presentation of particular results or the critical discussion of details than with the indication of a point of view; I have only wished to point out one of the pathways along which students of cytology are attempting to cooperate with students of genetics in their attack upon the problems of heredity. I would like to urge in closing that such explanations as have here been briefly indicated are not mere vague and general notions. They are specific and detailed interpretations of observed facts. They enable us, up to a certain point, to comprehend what goes on in the germ-cells, to form perfectly clear mental pictures of the apparatus of heredity, and of its mode of action in particular cases. They contain no mystical or transcendental element. I repeat that they are entirely in accord with the principles of chemical physiology, and with the experimental results upon the physiology of development. To this extent at least the explanations are real and represent a partial solution of the problem of heredity. No one would maintain that these explanations are final. I do not doubt that with advancing knowledge we shall in time come to look back upon many of our present conceptions as crude and naïve. Discovery in this great field of research has made no approach to its limit. Great progress in the future is certain. But if you ask whether we may hope to reach at last a complete or final solution of the problem of heredity, I fear the answer must be, no. The man of science should be the first to admit that science can not attain to a complete understanding of anything. The explanation of any phenomenon only uncovers new phenomena behind it that still demand explanation, in endless succession; and such is the essential characteristic of scientific progress. Science does not aim at ultimate explanations; and could we find them, science would be emptied of its interest to the investigator.

Edmund B. Wilson

Columbia University

CHANCELLOR JORDAN AND PRESIDENT BRANNER

AT the commencement of Leland Stanford Junior University on May 19 Dr. David Starr Jordan made a statement as follows:

I wish at this time to make a personal statement. In the interest of larger duties toward the university and toward the public, I have expressed to the board of trustees the wish to be relieved so far as may be from routine duties of the presidency.

In appreciation of this wish, and for the expressed purpose of allowing me "to represent more fully the university in its functions toward the public, and the relations of the university to educational agencies outside the university itself," the board of trustees at its meeting on May 23 will create the new office of chancellor of the university.

The position of president will be filled by Dr. John Casper Branner, my intimate friend for forty-three years, my academic colleague for twenty-nine years, and, as vice-president of the university for fifteen years, my closest administrative associate.

In accepting the chancellorship, and withdrawing from the immediate direction of administrative affairs, I shall abate no part of my interest in the university to which I have given the best years of my life, and to which I hope the best that remains will also be dedicated.

In placing the immediate control in the hands of one of the ablest of American scholars, one of the most successful of teachers and most loyal of men, I am sure that the board of trustees has made no mistake. So long as Dr. Branner shall direct its affairs the university will continue to develop the highest purposes of its founders, and of our colleagues, who, through twenty-two eventful years, have maintained and carried forward its standards and ideals.

Dr. J. M. Stillman then made the following statement:

With the consent of the president and at the request of members of the board of trustees, I am to speak a word of appreciation and welcome to President Jordan on assuming the new dignity of the chancellorship of the university.

The creation of this office has had two purposes: First—the division between the offices of chancellor and president of the burden of administrative duties and responsibilities hitherto vested solely in the president, and which the development of the modern university has made increasingly laborious and onerous. Second—in high appreciation of the great service President Jordan has rendered and is rendering, not merely to this university, but to the world's work in the cause of education, science and civilization, it is intended that the institution of this new office shall, by thus relieving him of much of the routine of executive work, enable him to devote his attention in increasing measure to the greater problems within and without the university.

For twenty-two years President Jordan has been the inspiration of Stanford University. What it is is due mainly to his high ideals, his breadth of outlook and warmth of sympathy. These qualities and abilities the university needs in the future as in the past, and these the office of chancellor ensures us. Trustees and faculty, alumni and students, will continue to profit by his wisdom and his enthusiasms. But it is also recognized that the world at large has a claim upon his abilities which it should be the mission of Stanford to further and to encourage.

In the belief that the division of administrative functions between two such cooperative and sympathetic leaders as Chancellor Jordan and President Branner, will promote the efficiency, usefulness and influence of the university, and that under their joint guidance the aims and ideals of Stanford University will be carried forward to greater and grander development, I venture to assume that I express the sentiment of the whole university community in extending to Chancellor Jordan our congratulations upon his well-deserved and welcome respite from a large share of administrative detail, and upon his increased opportunities for the highest service not only to this his university, but to the wider world beyond its gates.

THE PENSION PLAN OF THE AMERICAN MUSEUM OF NATURAL HISTORY

FOR a long time the trustees of the American Museum of Natural History have had under consideration a plan for adequately providing for employees who were of mature age or who had been long in the service, and who through their efficiency and faithfulness were entitled to some recognition. A plan was finally worked out by a committee of trustees and a committee of employees and was adopted by the trustees at the annual meeting in Feb-

ruary. The plan went into effect on March 1, 1913.

The plan is similar to those in successful operation in many great manufacturing corporations in the United States. It is a contributory system, the subscribing employees contributing 3 per cent. of their salaries, and the trustees contributing an equal amount to the fund.

The plan already briefly noted in SCIENCE provides:

1. Pensions.—Six classes of pensions according to length of service and age, the pensions varying from 25 per cent. to 50 per cent. of the average salary of the last three years.

2. Health Insurance.—Gratuity to the employee in case he is totally disabled through illness, or his position is abolished.

3. Life Insurance.—A gratuity to a beneficiary, in the event of the death of the employee, and under certain conditions in the event of the death of a pensioner.

4. For the return of the employee's contribution with simple interest at 3 per cent. in case the employee leaves the service of the museum before he is eligible for a pension.

The plan also makes provision for exceptional cases; leave of absence without pay; absence from the service for a certain period; return to the service; reduction of present rate of contribution when feasible, and for the amendment or alteration of the plan as circumstances may warrant in the future.

SCIENTIFIC NOTES AND NEWS

AT the annual meeting of the American Academy of Arts and Sciences held on May 14 last, it was voted to award the Rumford Premium to Professor Joel Stebbins, of the University of Illinois, for his development of the selenium photometer and its application to astronomical problems.

THE gold medal of the Swiss Geographical Society will be presented to Admiral Peary at a banquet to be given at Geneva, on May 31.

DR. ALFRED H. BROOKS, of the U. S. Geological Survey, has been awarded the Conrad Maltebrun gold medal of the Paris Geographical Society.

IN appreciation of his services in reestablishing the American Rainbow trout in Germany, Dr. Hugh M. Smith, United States Commissioner of Fisheries, has been presented with a medal by the German Fishery Society.

DR. HENRY S. CARHART, emeritus professor of physics in the University of Michigan, and Professor F. R. Moulton, professor of astronomy in the University of Chicago, have been made honorary corresponding members of the British Association for the Advancement of Science.

PROFESSOR HERMANN VON VÖCHTING has been elected a foreign member of the Linnean Society, London.

DR. GISBERT KAPP, professor of electrical engineering in the University of Birmingham, has been appointed president of Section G (engineering) of the British Association for the meeting to be held in Birmingham in September next.

ANNOUNCEMENT is made at the University of Chicago of the joint award to Dr. George L. Kite and Mr. Esmond R. Long, graduate students in the department of pathology and bacteriology, of the Howard Taylor Ricketts prize of $250 for original research in that department. The prize was established by the widow of Dr. Ricketts, who died in the City of Mexico from typhus fever contracted while studying the disease.

THE committee on medical research of the American Medical Association has awarded a grant of two hundred and fifty dollars to the department of bacteriology of the Hoagland Laboratory, Brooklyn, to defray the expenses of an investigation on the immunity reactions of edestin, a report of which is shortly to appear in the *Journal of Infectious Diseases*.

AMONG American astronomers who expect to attend the meeting of the International Solar Union to be held at Bonn, Germany, in August next, are Professors E. C. Pickering, Harvard College Observatory; Frank Schlesinger, Allegheny Observatory; J. A. Parkhurst, Yerkes Observatory; C. E. St. John,

Mount Wilson; H. N. Russell, Princeton, and J. S. Plaskett, Ottawa.

MR. EDWIN HATFIELD ANDERSON has been promoted to be director of the New York Public Library, succeeding the late Dr. John S. Billings.

C. S. RIDGWAY, assistant professor of botany at the Alabama Polytechnic Institute, Auburn, Ala., has resigned in order to accept an appointment in the Bureau of Plant Industry at Washington.

MR. LLOYD B. SMITH, professor of geology in the Carnegie Institute of Technology of Pittsburgh, Pa., has resigned to enter the employ of the Associated Geological Engineers in the examination of oil and gas properties.

DR. KARL GEISER, head of the department of political science in Oberlin College, will spend the summer in Germany investigating rural problems with special attention to rural local government.

A BIOLOGICAL expedition is being sent out by the University of the Philippines and the Bureau of Science. It started from Manila on April 5 for Taytay Bay on the northeastern coast of the Island of Palawan, and will remain in the field for two months. The party will consist of Dr. Merrill, chief of the division of botany of the Bureau of Science, Mr. Schultze, entomologist of the Bureau of Science; Mr. Rowley, instructor in geology, of the University of the Philippines; Messrs. Griffin, Cowles, Wharton, Day and Light, of the department of zoology of the university, and Mr. Barnes, teacher of zoology of the Bureau of Education. Including the assistants and laborers, the working party will consist of about twenty-five persons. The expedition will be under the direction of Professor Griffin. The region to which the party goes is entirely unexplored, but is said to be extremely rich in its fauna and flora.

AT the annual general meeting of the Institution of Civil Engineers, held in London on April 29, the result of the ballot for the election of officers was declared as follows: *President*, A. G. Lyster; *Vice-presidents*, B. H. Blyth, J. Strain, G. R. Jebb, A. Ross; *other Members of Council*, J. A. F. Aspinall, J. A. Brodie, W. B. Bryan, Col. R. E. B. Crompton, C.B., J. M. Dobson, Sir H. F. Donaldson, K.C.B., E. B. Ellington, W. H. Ellis, W. Ferguson, Sir Maurice Mitzmaurice, C.M.G., Sir J. P. Griffith, Dr. C. A. Harrison, W. Hunter, H. E. Jones, Sir Thomas Matthews, Dr. W. H. Maw, C. L. Morgan, B. Mott, A. M. Tippett, Sir Philip Watts, K.C.B., W. B. Worthington, Dr. Dugald Clerk, F.R.S., R. S. Highet, Dr. E. Hopkinson, F. Palmer and H. N. Ruttan.

THE special faculty committee from the University of Wisconsin appointed by President Charles R. Van Hise to receive and provide entertainment for the party of over 100 citizens of Pennsylvania, Maryland and Connecticut who spent the four days between May 21 and May 24, inclusive, inspecting the University of Wisconsin consisted of the following men: Professor L. E. Reber, dean of the Extension Division; Professor J. G. D. Mach, representing the College of Engineering; Frank Barron Morrison, representing the College of Agriculture; Professor Julius E. Olson, of the Scandinavian Department; Professor Ralph Starr Butler, of the Extension Division; W. H. Lighty, secretary of the Extension Division; Professor Dana C. Munro, head of the History Department; Professor George C. Comstock, head of the Astronomy Department; Dr. Hermon C. Bumpus, business manager of the university; Professor Scott H. Goodnight, of the German Department, and Professor E. A. Ross, head of the Department of Sociology.

PROFESSOR HENRY L. BOLLEY, head of the botany department at North Dakota Agricultural College, gave a public lecture at the College of Agriculture of the University of Wisconsin this week, in which he explained his theory for crop failure which results when cereal grains are planted in the same fields for several years. It was argued that the failure of the crop is not due to exhaustion of the soil fertility, but to the accumulation of soil parasites which are poisonous to the cereal grains.

Professor Julius Stieglitz, of the University of Chicago, lectured on May 21 at the University of Illinois on "Combustion, or the Electric Theory of Oxidation."

Dr. Frank Schlesinger, director of the Allegheny Observatory, delivered a lecture on "Astronomical Photography" before the Royal Astronomical Society of Canada, at Ottawa, on April 22 and at Toronto University on April 24.

The Bakerian lecture of the Royal Society was delivered by Sir J. J. Thomson on May 22, the subject being "Rays of Positive Electricity."

The first Wilbur Wright memorial lecture was delivered by Mr. Horace Darwin, F.R.S., at the Royal United Service Institution on May 21, under the auspices of the Aeronautical Society, which has raised a fund for the annual delivery of a lecture to commemorate the work of Wilbur Wright.

Addison Brown, ex-judge of the United States Court, for many years a member of the New York Academy of Sciences, a fellow and a patron, died at his residence in New York City on April 9, 1913, in the eighty-fourth year of his age. Judge Brown's favorite studies were botany and horticulture, but he also took great interest in astronomy. He was a member and benefactor of the New York Botanical Garden, one of its original incorporators, and, at the time of his death, its president. The council of the New York Academy of Sciences has passed a resolution, drawn up by a committee consisting of N. L. Britton, J. J. Stevenson and E. O. Hovey, which reads as follows:

Whereas, The council of the New York Academy of Sciences has learned of the death of Ex-Judge Addison Brown, who for many years has been active in promoting the welfare of botany and its related sciences in this city,

Resolved: That the council appreciates his services to science, and mourns his loss; that the above memorial and preamble be entered on the minutes of the council and a copy be sent to his bereaved family.

Dr. William Hallock, professor of physics in Columbia University since 1892, known for his researches in physics and for his interest in educational and scientific organization, died on May 20, aged fifty-six years.

Dr. William McMurtrie, one of the leading industrial chemists of the United States, formerly chief chemist of the Department of Agriculture and professor of chemistry in the University of Illinois, died on May 24, aged sixty-two years.

Dr. Ernest Kittl, director of the Royal Natural History Museum at Vienna, professor in the Vienna Institute of Technology, known for his contributions to geology, died on May 1, in his fifty-ninth year.

The U. S. Civil Service Commission announces an examination for electro-metallurgist on June 18, 1913, to fill a vacancy in the Bureau of Mines, Department of the Interior, for service in the field, at a salary ranging from $1,500 to $1,800 a year.

The Newcastle city council has decided to invite the British Association to meet in Newcastle in 1916.

The Minister of the Interior of the Canadian government has authorized the purchase and installation of a reflecting telescope of not less than sixty inches aperture for the Dominion Observatory. The telescope will probably be erected at a suitable site in the Canadian Rockies.

The legislature of California has passed a bill, drawn by Dr. Charles L. Edwards and introduced in the assembly by Mr. Frank H. Mouser, providing for a survey of the coastal waters preliminary to the establishment of a legally protected aquaculture. It is intended to divide the California coast into from three to five districts within which a considerable number of perpetual reservations will be formed for the natural and artificial propagation of animals and plants inhabiting the sea. The law will provide for leasing of sea farms and the patrol and protection of the coastal waters. The survey is placed under the Scripps Institute of Biological Research of which Dr. W. E. Ritter is director. A report is to be made to the governor on or before November 1, 1914.

THE United States Geological Survey had another close call on Sunday, May 18, in a destructive fire that practically gutted the basement of the entire building which it occupies. Owing to the congested condition of the store rooms and document rooms and to the escape of gas, the fire proved to be most stubborn and difficult to handle and resulted in the collapse of some 20 firemen, among them the chief of the Washington fire department. There was little flame, but the smoke poured in dense volumes from the Survey building, suffocating the firemen, who, however, fought desperately to keep the fire confined within the basement. The chief of the fire department states that had it got past the staircase which the men were holding and into the elevator shafts probably the entire building and possibly other adjacent buildings would have been consumed. The destruction, as it was, resulted in a loss of about $75,000, mostly in topographic maps, geologic folios, and reports, which, however, can be replaced. The unpublished data and other material in the upper floors of the building, having an estimated value between four and a half and five million dollars, were fortunately unharmed. "The only thing that saved the rest of the survey building from total destruction," said Director Smith in an interview, "was the efficiency of the Washington fire department, aided as it was by some fireproof doors leading from the basement to the upper hall, which had been erected on the recommendations of the chief of the fire department and the fire marshal. In its present quarters, after installing every possible safeguard, it appears that the government must rely upon the bravery and efficiency of the Washington fire department." The survey's campaign of last winter resulted in the authorization by congress of a new survey building to cost $2,596,000, but work on it can not begin until the money is made available in the next appropriation bill. Then, according to the usual time required in the construction of government buildings, it will be from three to four years before the survey can get out of its present quarters.

As a result of the fire in the Geological Survey building the director has announced a "fire sale" of geologic folios. The entire basement, in which the folios were stored, was filled with dense smoke and many of the folios were burned, others scorched, and all more or less damaged by water. With the approval of Secretary Lane the director announces that he will sell the entire remaining stock of some 150,000 folios, four fifths of which are probably as near perfect as goods usually offered in a smoke or fire sale, at the nominal price of 5 cents each. The regular retail price of the standard folios is 25 cents, but a few unusually large folios have sold for 50 cents, and the regular price of the "field edition" of the later folios, a more convenient form for use in the field, is 50 cents. All these are now to be had at 5 cents each, but no wholesale rate applies. The stock includes probably 50,000 to 100,000 copies on which the real damage is practically negligible. Application should be made to the director, U. S. Geological Survey, Washington, D. C., and remittance made by money order or in coin. Lists will be sent on application.

AN exhibition by the Pennsylvania Forestry Association was held in Horticultural Hall, Philadelphia, May 19 to 24. The association had arranged to make this exhibition as comprehensive as possible and, to that end, had included specimens of various woods, barks, leaves, seeds and other indicative features, growing seedlings, forest animals, fish, birds and insects of Pennsylvania, uses of lumber, wood preservation, wood substitutes, utilization of waste forest products. Exhibits were received from: Pennsylvania Department of Forestry, Chestnut Tree Blight Commission, Pennsylvania Fish Protective Association, Lumberman's Exchange of the City of Philadelphia, Pennsylvania State College, Pennsylvania State Museum, University of Pennsylvania, U. S. Forest Service, and a number of important associations or corporations interested in forest preservation, lumber production, etc. A series of addresses (some liberally illustrated) was given by men prom-

inent in the field of forestry, in the afternoons and evenings of the week.

The Wistar Institute in Philadelphia is remodeling a building 90′ × 31′, three stories in height, to be used for an animal house. The first floor and basement are to be entirely of iron and concrete construction with rooms varying in temperature and light according to the requirements of the colony. The building will have space sufficient for 1,000 cages, and will be equipped with steam heat, electric lights and hot and cold water. A covered passageway will connect it with the present museum and laboratory building. The building will contain a balance room where accurate weights and measurements may be taken. The necessary apparatus for the preparation of food and a crematory for the disposition of waste material and the heating of water will be installed. The building will furnish more ample space for the work in progress and give opportunities for extending the experimental work with animals. The colonies of white rats and opossums will be transferred from the laboratory building and the farm in New Jersey to this building as soon as it is ready.

A hundred new maps a year are the product of the big engraving and printing plant of the United States Geological Survey at Washington. About two atlas sheets a week are turned out in the construction of the great topographic map of the United States. The 15 new sheets added during the last six weeks to the 2,200 now carried in the regular stock show good examples of the widely different kinds of country covered by the government topographers. The areas mapped on these sheets range from the high forested mountain region of Colorado to the low, rich alluvial bottom lands of Mississippi and Louisiana—lands valuable for mineral resources, and lands rich in agricultural possibilities beyond the dreams of avarice. For any comprehensive development of these areas the topographic base map becomes the first engineering necessity. The scale of the maps varies from 1 inch on the paper, representing half a mile of country, with a contour interval of only 5 feet, for the Mississippi delta lands—showing a very detailed survey suitable for a drainage base—to 1 inch representing 2 miles, with 100-foot contours, for the Castle Rock quadrangle, Colorado—covering an area which does not require such refined work. The Castle Rock area contains coal and lignite and a report on it will be made later by the survey in the form of a geologic folio; but the vicinity of Castle Rock is also famous for its potatoes, which are comparable to the famous Greeley potatoes, and for other agricultural products. The western portion of the area includes part of the Pike National Forest, and for national forest administration the map affords an ideal base. Three of the maps represent lands along Mississippi River in the Yazoo Delta; they show parts of the Moon Lake quadrangle, the Hollywood (Tunica County) quadrangle and the Lake Cormorant quadrangle, all in Mississippi. These maps were made in cooperation between the Federal Survey and the Tallahatchie Drainage Commission of the state of Mississippi. They are on the scale of 1 inch to half a mile, with 5-foot contour intervals, and show every slough and swampy place and every inequality of the area which must be taken into consideration in planning a drainage system that shall make these lands the most productive in the United States. Farther down the river, in Louisiana, similar areas have been mapped in cooperation between the Federal Survey and the Fifth Louisiana Levee District of the state of Louisiana, the sheets portraying portions of three quadrangles, the Ashton Bridge, Millikin and Millikens Bend—land built from the silt brought down by the great river and of nearly inexhaustible fertility. Another map of an area cut by the course of the Mississippi—the Milan quadrangle, Illinois—shows country of a different character. Here at Rock Island the Father of Waters is less of a problem. This map was made in cooperation between the Federal Survey and the state geologist of Illinois. The scale of this map is 1 mile to 1 inch and the contour interval 20 feet. A still different contour interval—50 feet—is that of the map showing the Salinas quadrangle, in Monterey County, California, where the work was done in coopera-

tion between the Federal Survey and the state of California.

WE learn from *Nature* that it is proposed to celebrate the centenary of the foundation of the Indian Museum in Calcutta next February. Originally founded as a branch of the Asiatic Society of Bengal at the suggestion of Wallich, the botanist, on February 2, 1814, the Indian Museum became a government institution in 1867, after prolonged negotiations with the government of India, which accepted the society's collections to form the nucleus of an imperial museum in Calcutta. A centenary committee has been formed with Lord Carmichael, the governor of Bengal, as chairman, and Sir Asutosh, Mookerjee, vice-chancellor of the Calcutta University, as vice-chairman. The committee has decided to publish an official history of the museum, to raise a special fund for the improvement of the public galleries, and to hold a reception in the museum on the anniversary of its foundation.

UNIVERSITY AND EDUCATIONAL NEWS

THE General Education Board at its May meeting made appropriations of $837,600. Conditional appropriations for colleges are as follows:

John B. Stetson University, Deland, Fla.	$ 50,000
Northwestern University, Evanston, Ill.	100,000
Pomona College, Claremont, Cal.	150,000
Union College, Schenectady, N. Y.	75,000
Williams College, Williamstown, Mass	100,000

Appropriations for special purposes are as follows:

For demonstration work in agriculture in the southern states, which include the boys' corn club work	180,050
For the promotion of girls' canning and poultry clubs throughout the south	75,000
For agricultural demonstration work in five counties of Maine	14,500
For the beginning of agricultural demonstration work in New Hampshire	7,500
For professors of secondary education in the several state universities of the southern states	30,550
For state supervisors of negro schools in several southern states	20,000
Schools for negro students in the south	35,000

A NEW chair of bacteriology is to be founded in Edinburgh University under a bequest from Mr. Robert Irvine, of Royston, Granton. *Nature* states that at his death, eleven years ago, Mr. Irvine bequeathed 230 shares of £10 each in a company for developing the resources of Christmas Island for the purpose of establishing the chair when the interest from the shares should reach £25,000 or £30,000. The accumulated dividends on these shares now reach more than £30,000. It is understood that £25,000 will go towards the maintenance of the professorship, and that the remaining £5,000 will be used in providing the class-rooms, laboratories and the necessary equipment.

DR. P. M. DAWSON, a graduate of Johns Hopkins University, and of its medical school, and for eleven years a member of its physiological staff, has been appointed instructor in physiology at the University of Wisconsin Medical School.

THE following promotions and new appointments have been made in the Stanford University Medical Department: Dr. Thomas Addis has been promoted to associate professor of medicine, Dr. E. C. Dickson and Dr. W. W. Boardman have been made assistant professors of medicine; Dr. Leo Eloesser and Dr. F. E. Blaisdell have been made assistant professors of surgery. Dr. R. G. Brodrick, of the San Francisco Board of Health, has been appointed assistant clinical professor of hygiene and public health. In the division of medicine Dr. W. F. Schaller has been made assistant clinical professor, assigned to neurology, and Dr. J. M. Wolfsohn, clinical instructor, assigned to neurology. Dr. A. A. O'Neill has been promoted to clinical instructor in medicine and Dr. G. A. Rothganger has been appointed instructor in surgery.

DISCUSSION AND CORRESPONDENCE

THE CALIFORNIA ACADEMY OF SCIENCES

THE California Academy of Sciences in San Francisco is an institution of about 400 cor-

porate members. The academy is endowed with property approximating a million dollars in value, with the income of which collections and expeditions are maintained, and curators and other scientific and administrative employees are engaged. The members elect annually a board of seven non-salaried trustees, who fix the salaries of employees and otherwise administer the business affairs of the institution; and a non-salaried council, consisting of the president, two vice-presidents, two secretaries, the treasurer, the librarian and the director of the museum of the academy. The council plans the scientific work of the academy, appoints the curators, and recommends their salaries to the trustees.

Leverett Mills Loomis became curator of ornithology in the academy June 12, 1894, and has held the position continuously since that time. At the annual election in January, 1902, he was elected director of the museum, and was reelected to this office each year until and including 1912. In December of 1912 the nominating committee of the academy, regularly selected by the council and trustees in joint meeting, presented for 1913 a ticket of officers the same as the incumbents during 1912, with the sole exception that another candidate was nominated for director of the museum in place of Mr. Loomis. Although there is constitutional provision for contesting elections, no such contest was made, and Mr. Loomis's tenure of the directorship thereby came to an end with 1912.

During January and the first half of February, 1913, the council reappointed—and the trustees subsequently voted salaries for—all curators and assistants who had served during 1912, excepting Mr. Loomis, who was not reappointed as curator of ornithology.

At the stated meeting of the academy, that is to say, of the corporate members, on February 17, 1913, notice was given that the following resolution would be offered at the next stated meeting, and notice thereof was ordered sent to all members:

That the academy regrets the action of the council in not recommending to the trustees the appointment of L. M. Loomis as curator of ornithology, for the year 1913. Mr. Loomis has held this office for more than eighteen years, has twice built up a unique collection of birds for the academy, and his integrity, scientific competence and executive ability are unquestioned. The directorship of the museum is an elective office; the executive curatorship of the academy, though appointive, is an adjunct to the directorship, and may therefore justifiably go with it; but the curatorship of ornithology, like all other departmental curatorships, should be bestowed and reawarded only on the basis of merit and service. The failure to reappoint Mr. Loomis would therefore be a breach of fairness on a point of policy in which all reputable scientific institutions are in accord. It could be construed only as the intrusion of personal jealousies or political enmities into the field of scientific service, and would accordingly bring the academy into bad repute as to its equity in dealing with scientific employees. The academy therefore earnestly requests its council to appoint Mr. Loomis curator of ornithology for 1913, and urges upon its trustees to engage Mr. Loomis to take charge of the department which he has so long, so faithfully and so successfully administered, at the salary which it has been and is the practise to pay to academy curators giving full time to their duties.

At the stated meeting of March 3 a substitute for this resolution was offered by the original proponent, and adopted as follows by the academy:

As the council at recent meetings has failed to recommend the reappointment of L. M. Loomis to the curatorship of ornithology, and as it seems that said action could not have been made with all bearings of the question in mind, the academy herewith respectfully requests the council to appoint Mr. Loomis curator of the department of ornithology, and urges upon its trustees to engage him to take charge of this department, at the salary which is customarily paid by the academy to curators giving full time, with the following considerations in view: the long service of Mr. Loomis as a curator in the academy; the success achieved by him in accumulating large and valuable collections of birds; and the moral basis of the relation of an institution to employees of long standing.

At the next stated meeting of the academy, on March 17, 1913, the following communication from the council was read:

SAN FRANCISCO, CAL.,
March 17, 1913.

TO THE MEMBERS OF THE CALIFORNIA ACADEMY OF SCIENCES:

Having been officially notified of your request as adopted by resolution at the stated meeting of the academy on March 8, that Mr. L. M. Loomis be reappointed curator of the department of ornithology at the compensation which is customary for curators devoting full time to the affairs of their departments, your council desires to assure you that this request is receiving their earnest and most serious consideration.

For the council,
C. E. GRUNSKY,
President
J. W. HOBSON,
Secretary

At the stated meeting of April 7 the council reported to the academy that it had adopted the following resolution:

Having under consideration the request of the academy that the council reappoint Mr. Loomis curator of the department of ornithology for the current year, be it

Resolved, that it is the sense of the council that such reappointment would not be for the best interests of the academy.

Upon presentation of this report from the council, the following resolution was moved and was adopted by the academy:

The academy condemns and disavows the refusal of its council to reappoint L. M. Loomis curator of ornithology, without any charge having been brought against him after eighteen years of faithful and efficient service, as an act of unfairness, and as bringing reproach on the name and equity of the academy.

A. L. KROEBER

UNIVERSITY LIFE IN IDAHO

TO THE EDITOR OF SCIENCE: In reply to Professor Kellogg's letter in the issue of SCIENCE, May 16, 1913, regarding the reported dismissal of Professor Aldrich, of the University of Idaho, I may say that I have not made any recommendation regarding Professor Aldrich's tenure of office to the board of regents, nor to any member of the board—nor have I been asked to do so. I am informed that the action of the board was undertaken on its own responsibility and in fulfilment of its public trust, and the action was confirmed by the new board of education organized for all of the educational institutions of Idaho. I had no part in either proceeding. Accordingly, I am not entitled to share in either the credit or the criticism of the result. The rest of Professor Kellogg's letter is likewise unsupported in fact.

JAMES A. MACLEAN,
President, University of Manitoba

THE COTTRELL PROCESS FOR DEPOSITING DUST AND SMOKE

MR. LINN BRADLEY, of the Research Corporation, recently gave a lecture on the Cottrell Process[1] before the Lehigh Valley Section of the American Chemical Society. It was my privilege to help Mr. Bradley in his experimental demonstration of the process, and I suggested to Mr. Bradley a modification which proved to be very satisfactory for the lecture table.

A glass tube two inches in diameter and four or five feet long is supported in a horizontal position with a heavy wire or metal rod lying along the bottom of the tube and connected to one terminal of a small Holtz machine. A very fine wire is stretched through the tube and supported on two glass columns beyond the ends of the tube, and this fine wire is connected to the other terminal of the electric machine. The best procedure is to keep the machine running continuously with its terminals short-circuited. Then the tube is filled with any kind of smoke, the short circuit is quickly removed, and the smoke is seen to be deposited very quickly indeed.

Those who are not familiar with the process may be interested to know the action which takes place, which is as follows: The voltage between the fine wire and the heavy wire or rod is sufficient to cause a continuous corona

[1] The Cottrell process has been placed in the hands of the Research Corporation of New York City; any proceeds which may come from the practical use of the process are to go to the Smithsonian Institution of Washington.

discharge from the fine wire. In this corona discharge the air molecules are dissociated into ions and these charged ions quickly attach themselves to the particles of dust or tar. The intense electric field between the two electrodes then drags the particles of dust or tar to the large electrode, where they are deposited.

W. S. FRANKLIN

A LOCAL MAGNETIC STORM

IN SCIENCE, of March 21, reference is made to a paper just published by the Academy of Science of St. Louis with the above title. In this paper evidence is presented to show that atmospheric ions tend to set like magnets along the lines of the earth's magnetic field. The effect of gusts of wind in disturbing these ions, and in thus producing continual swaying of the lines of force due to variations in permeability, is pointed out.

A more local and somewhat similar magnetic storm may be artificially produced as follows:

Suspend a needle on a silk fiber. Provide it with a mirror, telescope and scale. Partially compensate the effect of the earth's field by bar magnets set in parallel position. Place two bar magnets on opposite sides of the needle, as in the Gaussian method of deflection. Place a plate of glass over one magnet, and sprinkle iron filings upon it. The deflecting effect of that magnet is increased. The needle no longer lies in the magnetic meridian. Balance the effect on the needle by adjustment of the other deflecting magnet and tap the plate. The permeability of the space around the magnet is again increased. A new readjustment may be made. Disturb the iron filings by means of a brush, applied to any small area of the plate. A magnetic storm is thus produced. If the filings were free to move without friction, they would all respond to the disturbance. The needle does respond. If the filings are made to accumulate near the poles, the deflecting effect of the magnet is greatly increased. If the magnet is supported at its middle part so that it is lifted above the plate of glass, the poles may be loaded with iron filings. The apparent magnetic moment of the bar may thus be increased about 8 or 10 per cent. Such a magnetic storm as is thus produced in the surrounding space appears to be similar to that produced in the field of the earth, when atmospheric ions accumulate around the magnetic poles of the earth. If any of these Faraday lines are disturbed, they are all disturbed. The balanced needle tells the story.

It seems very probable that the daily variations in the earth's field may be explained as due to this change in permeability brought about by ionization of the air by sunlight. The lines of force sway in opposite directions during the forenoon and afternoon of each day, their lateral motion being greatest in the equatorial belt. There is also apparently a similar swaying in a vertical direction.

In the forenoon the north end of the needle swings towards the west in the northern hemisphere, while the south pole swings towards the west in the southern. In the equatorial belt the needle suffers no change. These daily variations are modified by summer and winter conditions, as they should be if the above explanation is valid.

FRANCIS E. NIPHER

PLUS AND MINUS

IN a review of my book, "On the Foundation and Technic of Arithmetic," in SCIENCE, April 18, 1913, Professor Cajori, after quoting a sentence, says:

> In view of the fact that historians have been in doubt as to the exact origin of + and —, the authority for Halsted's categorical statement would be interesting.

Hoping the readers of SCIENCE may be of the professor's mind, I venture an outline.

Minus, as the oral rendering of the symbol —, takes a sense which did not exist in Latin of any period. Murray says it probably originated in the commercial language of the middle ages. In Germany the Latin words *plus* and *minus* were used by merchants to mark an excess or deficiency in weight or measure. The earliest known examples of the

modern sense of *minus* are German. In the *Bamberger Rechenbuch* (1483) the tare to be deducted from the weight of a package is called *das Minus*. An Italian writer of the fourteenth century used *meno* to indicate the subtraction of a number to which it was prefixed. The symbol itself, —, De Morgan, most sound and erudite of mathematicians, says arose as a merchant's mark. Its adoption was helped by its likeness to the *obelus* used by ancient critics to indicate that a passage should be removed from the text. This obelus or obelisk was a straight horizontal stroke, either simple (—), or with a dot above and one below (÷), and in Denmark the sign ÷ is used for *minus*.

English examples of *plus* do not occur so early as those of *minus; e. g.*, 1481–90 *Howard Househ. Bks.* (Roxb.) 417, v. yerdys, mynus the nayle, welwet blake. Cajori says Eneström shows "that with Widman + meant simply 'und' (and)," but how can this be brought to tally with the fact that Widman explicitly directs that the signs — and + be read *minus* and *mer* (mehr)? He uses them as signs already well known in his "Behende und hübsche Rechnung auf allen Kauffmannschafft" (1489); "was — ist, das ist minus, und das + ist das mer."

The adoption of the form + would be greatly helped by its likeness to a form of & = et, and Widman seems to have used the long preexistent form + in the two senses, *mehr* and *et*.

GEORGE BRUCE HALSTED

SCIENTIFIC BOOKS

Schutzfermente des tierischen Organismus. Ein Beitrag zur Kenntnis der Abwehrmassregeln des tierischen Organismus gegen Körper-, blut- und zellfremde Stoffe. By EMIL ABDERHALDEN. Berlin, Julius Springer. Eight text figures; pp. xi + 110. Paper cover, 3.20 M.; bound, 3.80 M.

In this little pamphlet Abderhalden gives an interesting survey of a method which the living organism employs to protect itself from the effects of foreign soluble substances which have entered its circulating juices. Under normal conditions, for example, proteids do not reach the tissue cells in their native state, but only as fragments. This degradation of proteids is normally accomplished by the ferments of the gastro-intestinal canal, and some of the degradation products, after absorption, are then synthesized by the tissues into its own characteristic proteid. Native foreign proteids in the circulation are useless and often directly harmful to the tissue cells. However, when this contingency occurs experimentally or through disease, the invaded body is not entirely helpless, but digestive ferments are formed in the circulation, possibly from the leucocytes, which attack the foreign proteid and digest it. These protective ferments are formed very swiftly and have been demonstrated by Abderhalden in the plasma or serum twenty-four hours after the subcutaneous injection of the foreign proteid, while the plasma or serum of normal, non-injected individuals shows no trace of this ferment.

Similar results were obtained by Abderhalden when carbohydrates were injected, or when fats were driven unchanged into the blood by forced feeding. Here again he was able to show the presence of ferments in the blood which were able to split the foreign substance.

These facts were established by Abderhalden and his pupils largely through the use of the polariscope. When optically active or racemic substances are split by ferment action, the optical activity of the mixture changes and this change shows, in the first place, that a decomposition has occurred; in the second place, the character of the change may show what substances have been formed, provided that the chemical structure of the original substance used is accurately known, which is the case with many of the optically active polypeptids.

The facts briefly mentioned above have received an important application in the diagnosis of pregnancy. The circulation of the pregnant organism contains cells from the chorionic villi, and the maternal body reacts to these cells by forming peptolytic enzymes

not present in the non-pregnant individual. If now the serum or plasma of a pregnant woman is added to peptone prepared from human placental tissue and the mixture observed by the optical method, the initial rotation changes, while with serum from a non-pregnant woman, the initial rotation remains unaltered. As this phenomenon could be detected as early as the first month of pregnancy, the procedure promises to be of great value in the differential diagnosis between extra-uterine pregnancy and tumors of the adnexa. It may, perhaps, be added that this ingenious method apparently does not remove all the difficulties and doubts which surround the early diagnosis of pregnancy, for recent investigations seem to show that a positive reaction may also be obtained under other conditions than pregnancy.

The booklet may be recommended as a very readable, stimulating summary of a large number of investigations by Abderhalden and his pupils.

J. Auer

Rockefeller Institute

Methods for Sugar Analysis and Allied Determinations. By Arthur Given, B.S. Philadelphia, P. Blakiston's Son & Co. 1912. Pp. 75. Price $2.00 net.

According to the preface, this book has been made, because, as the result of ten years' experience, the author has found that "it has become increasingly evident that the present methods as given in many of the books on sugar analysis and in the A. O. A. C. methods are not sufficiently explicit as to the proper method for a particular case, thereby confusing the novice, and making it difficult to secure uniform results. . . ."

The methods presented by the author are those which he, "from long practise on a very large variety of substances, considers to be best adapted for the purposes in hand."

In its limited range of seventy-five pages the book endeavors to cover the analysis of sugar-cane, cane-sugar and beet-sugar and their derived products, maple-sugar and maple-syrup, honey, commercial glucose, dextrin, starch, condensed milk, milk chocolate, etc. A few tables and illustrations are scattered through the text.

There is undoubtedly room on the shelf of many an analyst for a work which shall give tested and tried methods for the analysis of sugar and allied, saccharine, products. The author has brought together some material of value for this purpose; there is however—in spite of his conviction—room for considerable doubt as to whether his choice of methods would always commend itself to the approval of other experienced analysts.

In discussing the determination of sucrose in raw sugars, the use of Wiley's correction factor is recommended to obtain "the true polarization in sugars polarizing over 90°," if the temperature of polarization varies from 20° C., and then the author goes on to state that such correction is not applicable "where the reducing sugars exceed 3 per cent., as differences in temperature affect the reducing sugars more strongly than sucrose."

It would be interesting to learn why and how this arbitrary limitation of 3 per cent. has been decided upon by the author, and how he would obviate the disturbing influence of the precipitate-error in clarification which tends to offset the reduction in the specific rotatory power of sucrose caused by an elevation of temperature above the temperature at which the polariscope has been graduated.

The concise, not to say terse, manner of expression employed in the book is a good feature, yet a few additional words of explanation would not have been out of place in several instances, for example in giving the formula to be used in the Clerget method (p. 11). The novel way of printing the names of several of the more common sugars (p. 36) is apt to introduce more confusion in this already troublesome issue and the data given in that table are not always correct—thus, f. i. raffinose is hydrolyzed by invertase into d-fructose and melibiose, and not into d-glucose and d-galactose, as stated. Hydrolization of raffinose into d-galactose and sucrose is effected by emulsin.

F. G. Wiechmann

Principles of Economic Zoology. By L. S. DAUGHERTY, M.S., Ph.D., Professor of Zoology, State Normal School, Kirksville, Mo., and M. C. DAUGHERTY, Kirksville, Mo. Philadelphia and London: W. B. Saunders Company. 1912. Cloth, 12mo. Pp. 410. 301 illustrations. $2.00 net.

This recent text-book presents a number of commendable features and adds another to the rather numerous list of available text-books for the beginner in zoology. It seems more particularly adapted for the normal school work in which the authors are engaged, and this perhaps accounts for the effort to include a very large number of examples rather than to give a more detailed and exact description of representative forms in the principal groups of animals. Possibly the great number of forms mentioned would be confusing, but in the hands of a skillful teacher the book could certainly be very useful in the extending of acquaintance with animal forms in general. The economic feature of the work, which has been emphasized in its title, will make it welcome in many schools where attention to this phase of the subject is desired. While these references are usually brief they generally sum up in fairly compact form the more important economic points, and are quite suggestive for references to more extended works in this field.

The illustrations are numerous, usually well selected and very well printed, and add a very important feature to the book.

One point which seems somewhat of a blemish is the inclusion of a discussion of economic or other matter referring to an entirely different class under a sub-heading which is restricted to some minor division of the group, for example pages 40, 44 and 70, the discussion of economic importance included in a paragraph under minor classes in the branch, relate for the most part to species included in entirely different classes and without especial attention of the student might very likely be supposed to refer to the class in which the paragraph occurs. This fault is one which might easily be corrected by a different arrangement of sub-headings.

The substance in general seems to be carefully stated and while there are some errors, due no doubt to lack of first-hand knowledge, the preparation shows care, and while stated to be essentially a compilation, the authors are to be commended for the success shown in selection and presentation of material.

In typographical respects the book is very satisfactory and a credit to the publishers.

HERBERT OSBORN

THE MINERAL WEALTH OF CANADA

ALTHOUGH the discussion of reciprocity with Canada is now quiescent. yet all citizens of the United States are naturally interested in the development of our sister country. This is especially true of the readers of SCIENCE, because Canada has given to this country such a large number of eminent, influential and successful educators and scientists.

A recent publication of the Canadian Department of Mines gives us many items relating to the mineral wealth and to some of the resulting manufactures that ought to be of importance to our own people. This work is entitled "A General Summary of the Mineral Production of Canada during the Calendar Year 1911," by John McLeish, B.A., chief of the Division of Mineral Resources and Statistics.

From this we learn that the total value of the mineral products of Canada in 1911 was $103,220,994, or $14.42 per capita. The production was distributed amongst the various Canadian provinces arranged in order of the values as follows: Ontario, $42,796,162; British Columbia, $21,299,305; Nova Scotia, $15,409,397; Quebec, $9,304,717; Alberta, $6,662,673; Yukon, $4,707,432; Manitoba, $1,791,772; Saskatchewan, $636,706; and New Brunswick, $612,830.

Of these mineral products the metallic were valued at $46,105,423; the non-metallic at $57,115,571, of which $22,709,611 were for structural materials and clay products.

As a matter of comparison it is here pointed out that for the same year 1911 the mineral products of the United States, according to our

National Geological Survey, amounted to $1,918,326,253, of which $672,179,600 were for metallic and $1,245,896,653 were for non-metallic, with a value of $250,000 for materials not differentiated.

The table here given shows the relative values of some of the important mineral products common to Canada and this country. In those given Canada surpasses the United States in the value of its products only in nickel; but a few decades will doubtless see a great change in the relative values of the arsenic, asbestos (chrysotile), corundum and products of the two countries.

Metallic	Canada Value	United States Value
Pig iron	$12,307,125	$327,334,624
Silver	17,355,272	32,615,700
Gold	9,781,077	96,890,000
Copper	6,886,998	137,154,092
Lead	827,717	36,553,320
Zinc	101,072	30,964,794
Nickel	10,229,623	127,000
Non-metallic		
Coal	26,467,646	626,366,876
Natural gas	1,917,678	74,127,534
Petroleum	357,073	134,044,752
Peat	3,817	272,114
Clay products	8,359,933	162,236,181
Cement	7,644,537	66,705,136
Gypsum	993,394	6,462,035
Lime	1,517,599	13,689,054
Sand-lime-brick	442,427	897,664
Slate	8,248	5,728,019
Stone	4,428,757	77,108,567
Corundum and emery	161,873	6,778
Grindstones	52,942	907,316
Arsenious oxide	76,237	73,408
Phosphate rock	5,206	11,900,693
Pyrite	365,820	1,164,871
Asbestos	2,922,062	119,935
Mica	128,677	355,704
Mineral waters	223,758	6,837,888
Graphite	69,576	288,465
Salt	443,004	8,345,692
Talc	22,100	1,646,018

The mineral statistics were first collected for Canada in 1886, in which year the total value was $10,221,255, since which time the values have in general increased up to 1910, when they were $106,823,623 or the maximum. The falling off in 1911 is attributed to the prolonged strike of the coal miners in the Province of Alberta and the Crowsnest district of British Columbia, as the resulting scarcity of coal and coke in those provinces seriously interfered with the smelting operations.

A matter of practical value to the United States is the question of the mineral exports and imports of the Canadian provinces. The total value of the exports of mine products and the manufactures thereof was $52,546,593, of which $11,424,905 was for manufactures. Nearly all of the Canadian copper, nickel and silver are exported, as are a large part of the gold, asbestos and mica. The manufactures of mine products exported are chiefly iron and steel goods, aluminum, calcium carbide, lime, acetate of lime and coke. Of the exports $33,129,505 were sent into the United States; to the United Kingdom $6,726,015; while the next largest amount was to Newfoundland and Labrador, $580,632.

The imports into Canada of mineral products, chiefly in a manufactured or semi-manufactured condition, were in 1911 valued at $181,839,077. Of these imports iron and steel and the manufactures thereof amounted to $93,000,000; coal, ores, diamonds (unset) and bort, asphaltum, alumina, clays, etc., equaled $48,000,000; copper, gold, silver, lead, platinum, tin and zinc reached $18,750,000; while petroleum and clay products exceeded $11,000,000.

In view of the above facts the following excerpt from the report is of interest:

The great excess of imports over exports would seem to indicate the existence of large opportunities for the development not only of Canada's mineral production, but also of many manufacturing industries which utilize mine products as raw materials. The fact, however, must not be overlooked that the geographical situation of Canada and the United States, separated by an imaginary barrier 3,000 miles in length, evidently results, notwithstanding the tariffs on both sides, in a mutually advantageous interchange of trade. Then we find large exports as well as imports of coal and of agricultural implements. The con-

tinued large export of crude unrefined ores and metal products and the corresponding imports of refined and manufactured metal products still point to opportunities for the development of metallurgical industries as well as industries for the treatment, refinement and manufacture of non-metallic products.

Owing to our contiguity, our mutual relations, our essential unity of race and general characteristics and identity of language, we can but wish our northern brethren success in the development of their rich mineral country.

AFTER the preceding remarks relating to this subject were in type, but not yet published, a recent "Preliminary Report on the Mineral Production of Canada during the Calendar Year 1912, prepared by John McLeish, B.A.," has been received, although the data are subject to revision for a final report.

The total mineral production is stated for 1912 to be $133,127,489, or $29,906,495 over that of the preceding year, and $26,303,866 over that of 1910, heretofore the banner year. So notable an increase points towards a more general prosperity. The relative rank in production of the different provinces remains as in 1911, except that Alberta and Quebec have changed places, the product of the former being valued at $12,110,960 and the latter $11,675,682. For Ontario the value is $51,023,134, for British Columbia $29,555,323, and for Nova Scotia $18,843,324.

Of the value of the total production, as is quite general, the non-metallic is the greater or $71,949,500, while the metallic is $61,177,989.

The value of some of the more important Canadian mineral products are given in the table below.

	Value
Coal	$36,349,299
Silver	19,425,656
Pig iron	14,550,999
Nickel	18,452,463
Copper	12,709,311
Gold	12,559,443
Clay products	9,343,321
Cement	9,083,216
Stone	4,675,851
Asbestos and asbestic	2,979,384
Natural gas	2,311,126
Lime	1,717,771
Lead	1,597,554
Gypsum	1,320,883

The production of petroleum has been steadily falling off for the past five years, the value for 1912 being $345,050. The values of the production of copper, silver and gold have increased, especially in the case of gold from the Porcupine District. In brief it may be said that except for petroleum, the values of all the Canadian productions have increased since 1911.

For 1912 the value of the exports of mine products and of the manufactures of mine products has been $68,585,286, the chief ones being in order of value: silver, gold, copper, coal, nickel, asbestos, automobiles and aluminum.

By comparing the reports of previous years the mineral industries of Canada present, on the whole, very encouraging features for our northern neighbors and prove that a rapid development is taking place.

M. E. WADSWORTH

UNIVERSITY OF PITTSBURGH,
March 19, 1913

SPECIAL ARTICLES

ARTIFICIAL PARTHENOGENESIS IN FUCUS

THE occurrence of natural parthenogenesis or the development of the gametes without fertilization has been reported for several forms among the Phæophyceæ. Berthold and Oltmanns observed it in *Ectocarpus siliculosus,* which possesses, besides zoospores, gametes of two sizes. Both male and female gametes even in the same culture under certain conditions develop parthenogenetically. The question has been raised whether the so-called zoospores are not parthenogenetic gametes. Sauvageau observed that in *Giffordia secunda* antheridia were produced in greater numbers in July, but that none were formed in August or later, while numerous oogonia appeared at this season, many of whose

eggs cleaved very slowly without fertilization. The older observations of Thuret and of Crouan that the eggs of *Cutleria* develop without fertilization have been confirmed by Church, who reports that on the English coast *Cutleria multifida* develops mostly parthenogenetically, female plants being hard to find in August, and that scarcely any occur in the latter part of the season, the eggs developing without fertilization. As was previously observed by Thuret and Bornet, Williams has more recently found that the unfertilized eggs of *Dictyota* and of *Haliseris* segment a few times and then die.

It is evident that the Phæophyceæ show a strong tendency toward parthenogenetic development and that natural parthenogenesis may play an important part in the life history of several species. None of the Fucaceæ, however, have been reported as being able to develop without fertilization, although Thuret mentions that unfertilized eggs of *Fucus* kept for several days become pear-shaped and that a cellulose wall is sometimes present. Thuret's observations have not been supported by Farmer and Williams, who have never been able to observe cellulose walls around unfertilized eggs. My own observations are in harmony with those of Farmer and Williams. While working at the Marine Bioogical Laboratory at Woods Hole, the past summer, it seemed worth while to apply to *Fucus* eggs some of the well-known experimental methods used by Loeb, Winkler, Delage, Lillie and others, whereby unfertilized eggs of certain invertebrates have been made to segment under the influence of artificial physical and chemical stimuli.

Fucus vesiculosus, a diœcious species, occurs near the shores between tide marks at Woods Hole, and plants, both in the vegetative and reproductive conditions, are usually abundant. The spermatozoids and oospheres are usually discharged sparingly during ebb tide and abundantly during flood tide. Plants were collected during ebb tide, the distal portions removed and placed in dishes on ice over night. Care was taken that the conceptacles bearing eggs and sperms were kept separate. When it was desired to obtain the eggs and sperms, dishes containing conceptacles were filled with fresh sea-water, or after first exposing the conceptacles to a hypotonic sea-water, when eggs and sperms were discharged in large numbers. The freshly extruded eggs drop to the bottom of the dishes and can be taken up with a pipette and transferred to watch glasses for experiment. After a short time the eggs show a tendency to adhere very firmly to the bottom of the watch glasses so that fluids can easily be poured off and others added without losing the eggs.

The process of fertilization in *Fucus* has often been studied, and the details of development were especially studied by Thuret and later by Oltmanns. If the mature eggs and sperms are mixed together in the same dish in sea-water, the sperms collect in great numbers about the egg, and attaching themselves to the periphery cause the eggs to rotate rapidly by lashing the water with the cilia. Soon the eggs lose the power of attracting the sperms. They cease their rotation and settle down. Such eggs are fertilized. Farmer and Williams have shown that within five minutes after mixing the sexual cells the sperms have entered many eggs and within ten minutes the sexual nuclei fuse. Soon after fertilization a delicate membrane or cell wall is formed about the periphery of the oospore. As noted by Farmer and Williams, the character of the cytoplasm changes markedly, tending to assume a definitely radiating character, the lines radiating from the nucleus as a center. The oospores rest for about twenty-four hours, during which time there is a rapid increase in the thickness of the cell-wall and a further change occurs in the structure of the cytoplasm like those described by Farmer and Williams. At the periphery of the fertilized egg, just below the wall, the cytoplasm shows a definite alveolar structure.

After some time many of the oospores assume a pear-shaped form and by the next day all have divided. The first division, as has been observed by Rosenvinge and others, is at

right angles to the direction of the light. In the main my observations on the physiology of germination are in accord with those of Farmer and Williams. In watch glasses, placed on a laboratory table, the first division is usually at right angles to the bottom of the watch glass and at right angles to the direction of the light. Abnormalities in cleavage and development as described by Küster were sometimes, but seldom, observed. The cell away from the light is the rhizoidal cell, while from the other cell the young thallus develops. The subsequent cell divisions and growth of the plantlets in watch glasses follow the descriptions of Thuret and of Oltmanns and need no special mention. In watch glasses placed in larger dishes of sea-water, young plants of about 25 cells were grown in the laboratory. No attempt was made to rear the plants beyond these young stages.

In plants used to induce cell division by artificial means great care was taken to prevent contamination by sperms. The female plants were carefully washed with fresh water to kill any sperms which might adhere to them. None of the eggs obtained from such sterilized plants ever developed in the numerous controls, which were run in connection with the experiments, showing beyond a doubt that the female plants treated were absolutely sterile.

Loeb has shown that, when unfertilized eggs of the sea-urchin are placed for one and one-half to two minutes in a mixture of 50 c.c. of sea-water + 3 c.c. of 0.1 m acetic, butyric or other fatty acid and then transferred to normal sea-water, a fertilization membrane is formed. This method was applied to unfertilized *Fucus* eggs. In experimenting with the eggs those used at any one time were always divided into three lots. One lot was used as a control, another was fertilized and the third was treated with the solution. If a single egg in the control formed a cell-wall, which seldom happened, the three lots were discarded. In case the eggs were treated with acetic or butyric acid, as above described, a large number of them formed in about ten minutes a membrane or cell-wall which was exactly similar to the one formed about normally fertilized eggs. By plasmolyzing the eggs the membrane is readily seen. Eggs not treated with a solution or not fertilized undergo cytolysis and degenerate. In any case many of the eggs failed to develop, but about one fourth as many formed membranes under the influence of the solutions as were formed about fertilized eggs. After the formation of the membranes if the eggs are placed in hypertonic sea-water, 8 c.c.–10 c.c. of 2.5 m NaCl or KCl + 50 c.c., sea-water for 30 minutes and are then brought back into normal sea-water, development continues. Nearly all of the eggs which have formed a membrane become pear-shaped, showing a rhizoidal papilla, and by next morning have cleaved. The rhizoidal cell is cut off and one or more cleavages have taken place in the other portion of the sporeling. If the cultures are properly aerated, sporelings develop resembling in every respect those grown from fertilized eggs. In place of sea-water containing a fatty acid, solutions of various other cytolytic substances were used, but none stimulated membrane formation or development as well as the acids.

With regard to the first formation of the cell-wall over the surface of isolated masses of plant protoplasm, it is usually attributed to a process of secretion by the outer layer. That the process is a rapid one is shown by the fact that in *Fucus* eggs a cell-wall is formed in ten minutes after the entrance of the sperm. Cell-wall formation may also be artificially induced, as shown above, by various substances. In some cases a cell-wall may appear under certain conditions on the surface of plasmolysed protoplasts in fifteen minutes, as has been shown by Klebs, Palla and others, while in other cases hours are required for wall formation. It would appear that the action of the acids in inducing a cell-wall to be formed about the unfertilized *Fucus* eggs is similar to the action which calls forth membrane formation in the animal egg. Considerable evidence exists indicating that the essential con-

dition for the formation of the fertilization membrane in many animal eggs is an increased permeability of the plasma membrane for substances which pass out and harden in contact with the sea-water. The rôle of the acid, etc., in membrane formation is held by many to be the increasing of the permeability of the plasma membrane of the egg.

That the first effect of the sperm of the Fucaceæ upon the egg is to cause cell-wall formation, conditioned as it seems to me by a momentarily increased permeability of the plasma membrane just as in certain animal eggs, is apparent from the observations of several investigators. Farmer and Williams furnish remarkable evidence showing that the entrance of the sperm supplies the stimulus which leads to the formation of the cell-wall in *Halidrys*. In this form pieces of the oospheres are sometimes pinched off during extrusion. These observers note that such pieces sometimes attract the sperms and become fertilized, surrounding themselves with a cell-wall in the normal way. The cases of merogony induced by Winkler in *Cystosira barbata* may, I think, be explained by assuming that the sperms increase the permeability of the non-nucleated fragments, as well as being the underlying cause of further development. In the normally fertilized eggs of *Halidrys* Farmer and Williams note that the entrance of the sperm causes the eggs to swell and become more transparent. In some cases movements of vacuoles are discernible and the nucleus may change its position. They conclude that these alterations ensue as a definite result of the stimulus given by the sperm. The fertilized egg becomes covered by conical projections, from each of which a fine thread projects, consisting of a series of droplets. After 3–5 minutes the fertilized egg resumes its spherical shape and decreases in diameter. They also observed that the sperms were repelled from fertilized eggs and conclude that this is due to the excretion of some substance which exerts a negative chemotactic and injurious effect on the sperms. Such eggs at once become invested in cell-walls, while others not exhibiting these phenomena after a time degenerate.

The results of my experiments, in which cell-wall formation and subsequent development were induced in unfertilized eggs of *Fucus*, and the data mentioned above, seem to show that the first effect produced by the sperm upon the egg is purely superficial, causing an increase in the permeability of the plasma membrane. These conclusions are in harmony with those of certain animal physiologists. Therefore, theoretical considerations as to the causes of the change in permeability and the stimulus to further development need not be discussed here.

As yet I have been unable to investigate the nuclear behavior of the parthenogenetic plants of *Fucus*. Farmer and Williams, agreeing with Strasburger, hold that the *Fucus* plant contains the diploid number of chromosomes and that the reduction to the haploid number occurs during the first division in the oogone and in the antherid. Since the eggs of these plants induced to develop without fertilization contain the haploid number of chromosomes, one can assume, unless a regenerative doubling in their chromosome number occurs, that the nuclei of the sporelings contain the haploid number. It would be of interest to grow these parthenogenetic sporelings to sexual maturity and to investigate the chromosome behavior especially during oogenesis and spermatogenesis. Hoyt has carried sporelings of *Dictyota* to maturity by sowing the spores on oyster shells, and transferring these to the open water after the sporelings had become firmly attached. Lewis had used similar methods successfully with the sporelings of certain Florideæ. Fertilized eggs of *Fucus* when allowed to settle down on oyster shells in the bottom of dishes become firmly attached and produce the sporelings. *Fucus* eggs induced to develop by artificial stimuli also produce sporelings on oyster shells. For lack of time I was unable to transfer them to the open water, but the method is suggestive.

J. B. Overton

University of Wisconsin

ON THE COLLOID-CHEMICAL ACTION OF THE DIURETIC SALTS[1]

THIS paper reports a further series of experiments on rabbits which show that *the colloids of the cells and of the juices which bathe them (blood and lymph), and the state in which these exist determine in the main the amount of water such cells and body fluids hold under both normal and abnormal conditions.*

The maintenance of a urinary secretion depends upon two factors, first, upon a supply to the kidney of "free" water out of which to make urine, and second, upon the ability of the kidney cells to do the work necessary in transferring the water from the blood into the uriniferous tubules. Urinary secretion may fail through interference with either of these factors.

The intravenous injection of any amount of blood, blood serum, or a hydrophilic colloid in which all the water is bound to the colloid, is followed by no increase in urinary secretion. This is because no "free" water is given. The same amount of water when given "free," as in the form of a saline solution, is followed by a prompt increase in urinary flow.

When equal amounts of sodium chloride solution are injected we get increasingly greater amounts of urine with progressive increase in concentration of the salt. This is because the salt dehydrates the body tissues, and the "free" water thus obtained is added to that which is being injected. The salt owes its action as a diuretic primarily not to any effect upon the kidney, but to its action in dehydrating the colloids of the whole body.

When equal amounts of equimolecular solutions of different salts are injected it is found that the order in which these produce diuresis is the same as the order in which they dehydrate (protein) colloids. Thus in a series of chlorides the metals arrange themselves in the following order, in which that most powerful in producing a diuresis is named last: sodium, magnesium, strontium, calcium. In a series of sodium salts the acid radicals arrange themselves as follows: chloride, nitrate (?), bromide, iodide, acetate, phosphate, sulphate. The greatest diuresis of all is produced by a salt which is made up of a powerfully dehydrating base with a powerfully dehydrating acid, for example, magnesium sulphate.

The diuretic action of these different salts parallels completely their dehydrating effect upon (protein) colloids, a fact which again indicates that they owe their action primarily to their effect upon the body as a whole, acting as diuretics only as they furnish a working kidney "free" water.

The experiments also betray no evidence of an antagonism between monovalent salts such as those of sodium, and bivalent salts such as those of calcium, strontium, etc. Such salts act *synergetically*, not antagonistically, in physiological reactions, just as they do in test-tube experiments on simple protein colloids.

It is impossible to explain these salt effects upon any osmotic basis, for there exists not even the grossest parallelism between the physiological effect and the osmotic pressure of the solutions employed. Our critics have maintained that osmotic phenomena dominate the picture of absorption and secretion in "living" tissues. They have grown willing to grant that the colloidal theory is operative in "dead" tissues. In the described experiments the osmotic element can hardly be found; the colloidal element appears plainly in every one of them. It is needless to add that our rabbits were alive.

The detailed laboratory findings upon which this article is based have been submitted for publication in the *Kolloid Zeitschrift*.

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ANNE SYKES
EICHBERG LABORATORY OF PHYSIOLOGY,
UNIVERSITY OF CINCINNATI,
April, 1913

[1] A preliminary communication.

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

THE one hundred and sixty-third regular meeting of the American Mathematical Society was held at Columbia University on Saturday, April 26, extending through the usual morning and

afternoon sessions. The attendance included fifty-seven members. President E. B. Van Vleck occupied the chair, being relieved by Ex-Presidents H. S. White and T. S. Fiske. The following new members were elected: Professor E. H. Jones, Daniel Baker College; Mr. L. B. Robinson, Johns Hopkins University; Dr. H. M. Sheffer, Cornell University; Dr. W. B. Stone, University of Michigan; Professor F. B. Wiley, Denison University. Six applications for membership were received. Professors D. R. Curtiss and P. F. Smith were elected members of the editorial board of the *Transactions* to succeed Professors Böcher and White, who retire in the fall.

The following papers were read at this meeting:

E. L. Dodd: "The error risk of the median compared with that of the arithmetic mean."

B. M. Batchelder: "The divergent series satisfying linear difference equations of the second order."

P. M. Batchelder: "The hypergeometric difference equation."

H. J. Ettlinger: "On a generalization of a Sturmian boundary problem."

R. L. Moore: "Concerning pseudo-Archimedean and Vollständigkeit axioms."

J. E. Rowe: "The relation between the pencil of tangents from a point to a rational plane curve and their parameters."

E. G. Bill: "Analytic curves in non-euclidean space (third paper)."

Joseph Slepian: "On the functions of a complex variable defined by a differential equation of the first order and the first degree."

Nathan Altshiller: "On the cubic with a double point."

C. F. Craig: "Ruled surfaces associated with certain rational space curves."

H. M. Sheffer: "The generalized principle of duality in Boolean algebras."

T. H. Gronwall: "On the maximum modulus of an analytic function."

L. L. Smail: "Note on the summability of properly divergent series."

Maurice Fréchet: "Sur les classes V normales."

Maxime Böcher: "An application of the conception of adjoint systems."

G. D. Birkhoff: "Note on the gamma function."

G. D. Birkhoff: "Solution of the generalized Riemann problem for linear differential equations, and of the analogous problem for linear difference and q-difference equations."

L. P. Eisenhart: "Transformations of Guichard."

E. V. Huntington: "Sets of independent postulates for betweenness (second paper)."

A. D. Pitcher: "On the connection of an abstract set, with applications to the theory of functions of a general variable."

A. D. Pitcher: "Concerning the property Δ of a class of functions."

R. G. D. Richardson: "Oscillation theorems for a system of n linear self-adjoint partial differential equations of the second order with n parameters."

H. H. Mitchell: "On some systems of collineation groups."

H. S. Vandiver: "Symmetric functions formed by certain systems of elements of a finite algebra, and their connection with Fermat's quotient and Bernoulli's numbers."

C. A. Fischer: "The derivative of a function of a surface."

C. T. Sullivan: "Properties of surfaces whose asymptotic curves belong to linear complexes."

S. D. Killam: "A note on graphical integration of a function of a complex variable."

K. P. Williams: "On the asymptotic form of the function $\Psi(x)$."

M. G. Gabba: "A set of postulates for general projective geometry in terms of point and transformation."

W. A. Hurwitz: "Postulates sets for abelian groups and fields."

Edward Kasner: "The interpretation of the Appell transformation."

G. M. Green: "Systems of k-spreads in an n-space."

J. W. Young: "A new formulation for general algebra."

J. W. Young and F. M. Morgan: "The geometry associated with a certain group of cubic transformations in space."

The summer meeting of the society will be held at the University of Wisconsin, Madison, Wis., during the week September 8–13. The last four days of the week will be devoted to a colloquium, at which courses of lectures will be given by Professor L. E. Dickson, of the University of Chicago, on "Certain aspects of a general theory of invariants, with special consideration of modular invariants and modular geometry"; and by Professor W. F. Osgood, of Harvard University, on "Topics in the theory of analytic functions of several variables."

F. N. Cole,
Secretary

SCIENCE

FRIDAY, JUNE 6, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

SOME PROBLEMS OF MEDICAL EDUCATION[1]

THE education of medical students has been a subject of perennial interest to both teachers and practitioners for a long time, and although great advances have been made, there is still general dissatisfaction with the results as shown by examination tests and the ability of recent graduates to meet the emergencies or even ordinary duties of professional work.

At the meetings of the council on medical education of the American Medical Association, the confederation of examining boards of the United States and our own association, the faults in preliminary education, in professional training, and the needs of still greater clinical opportunities, have been pointed out and are familiar to you all. Out of all these discussions, two general educational remedies have been advocated.

1. That one or two years of college work, which shall include one year of chemistry, physics and biology, be added to the preliminary training.

2. That a hospital or clinical year be added, making the medical course, as measured by the standards of England and Germany, six years.

In these two propositions certain questions arise which concern this association especially. For us the questions are not merely academic, but questions of administration, standards and pedagogics.

The house of delegates of the American Medical Association at its recent meeting

[1] Presidential address, delivered before the Association of American Medical Colleges at Chicago, February 26, 1913.

decreed that for a medical college to be put in the highest rank, the requirement of one year of college work, including instruction in chemistry, physics and biology, is necessary. This has focused attention on this proposition and many colleges will feel compelled to require it.

In discussing this proposition, the first question that arises is: How is the student to obtain this year's work in the designated sciences?

In states with state colleges or universities, the question has been answered. The high school and university courses are so correlated that with a minimum amount of disturbance the student passes from one to the other. The financial aspect is not a burdensome one, as the fees in the state-supported institutions are relatively small. But in the greater part of the country no such coordination exists, the colleges and universities are disassociated from the high schools, so that there is a greater or less impediment to students passing from the high school to the colleges, as they are not accepted on their high-school credentials. In some, the students are admitted only on examination in addition to their credentials, and others demand special preparation in subjects not included in the high-school course. Universities and colleges should feel it their duty to correlate their entrance requirements with the high-school courses of their locality.

In this connection another obstacle is met with in localities where the universities and colleges are not part of the general educational system, *i. e.*, the attitude of these institutions toward one- or two-year students who are taking the course to meet the medical school requirements. It does not, however, apply to universities with medical schools. The universities frankly admit that they do not want these students, and when we discuss the requirements as related to sciences and languages with them, they say: "Why should we modify our curriculum to meet the needs of these one- or two-year students? We are not conducting this college as a preparatory school for technical or professional education." And the head of one of the largest universities in the east with no professional school attached, said: "If I find men coming here to meet this requirement, I will change the course so that they can not get the science branches demanded in less than three years."

To meet this requirement, must the course be taken only in an institution having the right to grant the B.A. or B.S. degree? Should the requirement read: "One year's work of college standard, which year must include instruction in chemistry, physics and biology. This year must be in addition to the high-school course"?

This raises at once the most important question of equivalents and all the dangers of evasion. It has been suggested that these courses might be given in technical high schools which only admit students after the completion of a high-school course, and in support of the suggestion, it has been claimed that such a course would be much more definite than that given in many literary colleges, and it would be under the supervision of the educational department of the state. Many deny the right of high schools to do the work of the colleges, and, in addition, urge that it is not meeting the spirit of the requirement.

This raises the next question. What is the object of this added year of preparation?

In general terms, the answer is: "Power to grasp professional subjects."

Is this power gained best by increase in general education in the so-called "humanistic" or "culture" courses, or by tech-

nical training in the sciences? The view point of the institution in which the instruction is taken will determine the character of the course. In institutions with medical schools, the course will be correlated to the future needs of the student. In colleges without such affiliation, these courses will be part of the general college régime which deals with education so as to insure a wide and general character to the subjects it embraces, whereas it is imperative for the future use of such studies, whether in engineering or medicine, under the pressure of modern life, that the student should be equipped with the necessary knowledge in the shortest possible time that is compatible with thoroughness. From a practical point of view, generalities must be abandoned and definite limits set. Are the undergraduate college teachers willing to do this, or will they insist on generalities?

This raises the question of the cultural value of the liberal courses as opposed to the so-called science or technical subjects. All agree that "the preparatory training for life should be liberal and humanizing; that the course of study in the college, in addition to having a broadening influence, should also inculcate in the student some specific kind of mental training which will fit him better to take a high rank in whatever career he may happen to select." As students enter the college to later select medicine, the studies should by scope, content and method give him the specific kind of mental training that will better fit him for his life work.

While valid objection might be raised against introducing into the college course professional instruction, as defined by Karl Pearson, *i. e.*, "training in the art of a specific profession," this does not hold against technical education in the underlying subjects of a profession, and for the medical profession these subjects are the natural sciences, chemistry, physics and biology being specified as those most helpful.

It has been said that these subjects are lacking in educational value from the standpoint of "general training"; that they do not provide mental training for the man who has no intention of entering a profession. The answer to this objection is that the fault is not in the subjects, but in the manner in which they are taught, and also in the content of the course. President Hill, of the University of Missouri, has emphasized the value of motive in acquiring knowledge and gaining insight into a subject. "Insight normally brings culture, especially in human life, and vocational motive not only does not interfere with, but tends to foster, the development of a deeper and truer insight into the significance of scientific knowledge."

Can a knowledge of chemistry, physics and biology be acquired in one year of college work with sufficient fulness to be of value to the student in his medical course? There are two opinions on this question: one, that a single year is inadequate; that these subjects should be taught as pure sciences and on general lines with no regard to future use; that in one year the student will have only a verbal acquaintance with things that he does not understand. Those who hold this opinion are urging the two-year course, not so much as a preparation for medicine as for the general cultural value. They would have not more than a single year's work in each of the science branches and more of the general college subjects added.

The other opinion is that one year is a sufficient time in which to gain a familiarity with the *principles* of those subjects which have a bearing on medical sciences.

This is a very different thing from teaching them as medical subjects. It would set definite limits on the course and not try to cover the entire science in a single year. In chemistry the general basic principles underlying the science rather than isolated facts should be taught, and these principles can be learned just as well by studying substances and processes in the laboratory which have a distinct bearing on medicine, rather than on metallurgy or mineralogy. Probably the college course in chemistry is the best standardized of all.

In physics, the student needs a fairly wide knowledge so far as it can be gained without higher mathematical processes. Laboratory instruction should form a large part of it. The important topics are specific gravity or relative density (there should be real understanding of what these terms mean), osmotic pressure and diffusion, hydrostatics, acoustics and its common application to sound, pitch, resonance, optics, laws of refraction and reflection, as applied to mirrors and lenses. Heat; the thermometer, laws of specific heat, cryoscopy, calorimetry and the relation of heat to work. Electricity; the elements of static electricity and of galvanic and foradic currents. In mechanics, the statical aspects only. Much of the dynamics usually taught should be omitted, also the study of absolute temperatures, absolute units. The object of the course in physics is that

the student may gain a comprehensive and connected view of the most important facts and laws of elementary physics. There is need of limiting the course in physics, because the courses in universities and colleges are more adapted to train professional physicists than future practitioners of medicine. The two need a different training. A study of the curricula at many colleges shows that in one single year an elementary course requiring very little mathematics is followed by a highly specialized mathematical course, having practically no reference to the experiences of life.

In the biological course, it is important that the student should become conscious of the characteristics of living things. Without some general biological training, it would be impossible for him to give to his medical physics and chemistry a biological application. By dissection of a few of the lower types, by witnessing a few simple physiological experiments on plants or animals, by examination of simple tissues under the microscope, he should obtain an idea of the correlation between structure and function, the general build of the elementary tissues; and the process of digestion, respiration, assimilation and reproduction, which together make up our conception of a living organism. A comprehensive view of the subject, but well within the power of the student to understand, is rarely given. On the other hand, a great deal of useless information is given and much precious time and energy is wasted on botany, zoology and highly specialized courses.

By such courses, beyond the accumulation of facts in the different sciences which the student may obtain, he should have become an accurate observer, been interested in the art of inquiry, have acquired a fair degree of manual dexterity and use of laboratory instruments, have cultivated proper habits of study and work—in fact, trained for efficient professional study. His mental horizon should be extended, a new attitude of mind toward his work fostered; his reasoning faculties should be developed so that the insistent "*why?*" compels him to seek the answer. To give this training demands that the subjects are taught in an intensive manner, that interest is aroused, that the student feels that the subjects are important, not only as sciences, but for their future professional application. Unfortunately, the generalities

of the college courses do not often give this direction.

It must be borne in mind that it is possible to educate a student away from scientific thought, as well as toward it. It has been disappointing to note the effect of a general college education on medical students. They come to the medical school often unwilling to adjust themselves to the régime. They have lost much of their receptiveness, they are to a degree mentally arrogant, they have a pseudo-philosophical and not a scientific frame of mind. It is for this reason that often the high-school graduate gets more out of the course than the man with a B.A. degree.

In demanding one year of college work as an entrance requirement, the medical schools have not only a right, but a duty, to demand of the colleges that the course be standardized; that it be made worth the students' time, both in content and methods. Otherwise it is useless, both from the cultural and technical standpoint. It will be not a specific, but a quack remedy, prescribed for the cure of our educational illness. I firmly believe in better preliminary education of the medical student, and am only raising these questions that they may be discussed.

What influence will the added year of preliminary training have on the medical course? Will it allow of changes in our present curriculum? For it is conceded that at present it is overcrowded; that the difficulties of medical education are increasing; that the burden is heavy on both teachers and student; that there is a waste of effort that is almost tragic.

The problems of medical education are bound up with the progress in medicine and therefore can not be solved once and for all, but must be constantly under consideration and adjustment. In all consideration of them, certain facts must be kept constantly in mind. The period of study can not be indefinitely extended. There must be a proper proportion between the period of preparation for and practising of a profession. As Professor Starling has so well put it, "The brain of man does not increase in capacity or in power of assimilation with the growth of science." "How is the necessary limited time of medical education to be most profitably employed in imparting to the student such knowledge as is most useful to him in his future career?" The effect of the overloaded curriculum on the student is most harmful. He gets a smattering of many things, instead of a thorough grounding in principles. He forms faulty mental habits, early becomes surfeited and loses interest in the work; everything is gauged by examination value; he has no sense of proportion, small details and facts loom large, basic principles are unimportant. At what point should the unloading begin? What ballast should be thrown overboard?

Notwithstanding the work of the committee on curriculum of this association and that of the council on medical education of the American Medical Association, the usual medical course still contains much useless ballast, some of it traditional, some of it due to demands of state board examinations and some gradual "accretion" due to a desire to meet the advances in medical sciences.

Professor Welch, in opening the discussion on "The Medical Curriculum" at the meeting of this association at Baltimore, said:

One of the fundamental things is to inquire, What is the object of medical education? To make good doctors; there is no question that that should be the underlying conception in our schemes for medical education, and unless you can define a given course as bearing on that training, it has no place in the medical curriculum. *If the training in physiology can not be shown to be to make good doctors, it is*

not defensible. The same can be said of pathology, or any other subject in the curriculum. The ultimate aim of medical education is to make good practitioners of medicine. Another thing that confronts us at the start of any consideration of the medical curriculum is: What kind and what amount of knowledge can the student acquire during the four years of his medical education? The most you expect is to give to the student a fair knowledge of the principles of the fundamental subjects in medicine, and the power to use the instruments and methods of his profession; the right attitude toward his patients and toward his fellow members in the profession; above all, to put him in the position to carry on his education, because his education is only begun in the medical school. The student does not go out a trained practitioner, a trained pathologist, or a trained anatomist or a surgeon.

President Pritchett in the introduction to the "Bulletin on Medical Education in Europe" says:

> Even if one may assume that students enter the study of medicine properly trained in the fundamental sciences, the problem of the curriculum is a serious one. The report shows a general tendency toward overburdening. The question naturally arises, What ought the course of study of a technical or professional school to accomplish? The medical school can not turn out finished doctors. It can not teach all that it is important for the practitioner to know. Under these circumstances it does best to accept frankly certain limitations, and so to train its students that they will be disposed subsequently to remedy their own deficiencies. Inclination of this kind appears most likely to result from a training that prescribes only the indispensable minimum, requiring in addition more thorough performance in a few directions and leaving opportunity for still further effort to those of greater energy, interest or ability.

Is not some of the overload due to our having ignored the above facts, because we have tried to teach all the sciences and all the art and science of medicine, to turn out specialists in medical sciences, in research work, and in medicine and surgery.

The past decade has seen a most marvelous improvement in the teaching of medical sciences and opportunities for laboratory work. Gone, never to return, are the purely professional courses in anatomy, chemistry and physiology, given by busy practitioners or recent graduates, whose knowledge of the subject was but little in advance of the students, and who were able to repeat a few simple experiments. To-day the laboratory courses in the medical sciences are far more extensive than even the German schools. In this country the laboratory courses are paramount and the lecture courses subordinate; in Germany it is the reverse. The development of these courses has been so rapid that the necessity for setting limitation on them has not been observed. President Pritchett says:

> The medical curriculum, extended as it is in Europe, over five years, has reached the limits of its capacity; it can contain no more. Exactly the same process has occurred in medicine as has taken place in the training of engineers. In fact, experience in these two kinds of technical education during the last fifty years has been strikingly similar. Most naturally the medical school and the engineering school have endeavored to include in their teaching some knowledge of the new sciences developed in the last half century and of their application. As a result, the burden devolved upon students of medicine and of engineering has grown enormously. The respective curricula have been formed almost altogether by accretion, something being put in, little or nothing taken out. As a result, both the medical student and the engineering student are called upon to carry, not only a heavier load, but a load made up of more parts.

As students come to the medical schools with better preparation in the sciences, there is a tendency to add more and more detail; to extend the laboratory courses and insist on all the precision, the rigor and the abstraction of the research laboratory; to teach the subjects as pure science and not as applied; to lose sight of the ability of the student; to go beyond the need of the future practitioners of medicine, and plan the course as if all were to be

chemists, physiologists, pathologists or research workers. The whole body of students should not be compelled to spend a disproportionate amount of time and energy upon topics which will be of use to a few only. Opportunity should be given to those who wish to pursue any subject beyond that given as part of the general instruction, but unfortunately our rigid curriculum prevents it. The student's time is too fully occupied to allow of electives or to take extra work in subjects in which he is interested, without neglecting obligatory courses. It has been well said that our system is a "lock-step" one.

The student should be so instructed in the fundamental principles of the science subjects that after graduation he may keep pace intelligently and be able to utilize further discoveries of these sciences as applied to scientific medicine. Beyond this we can not go.

In our attempt to make our student scientific we are defeating our object by insisting on too great detail, before he can understand the principles. The teaching of a subject as a pure science, without application to clinical subjects, causes him to have no motive or interest in it and to throw it overboard as soon as examinations are past.

While all agree that the inductive method is the proper one, when pushed to the extreme the method breaks down. This is a woeful waste of the students' time in the "work it out for themselves" method of some teachers.

The statement is frequently made that students do not carry with them beyond the examination period that general knowledge of anatomy, chemistry, physiology and pathology which should be a lifelong possession.

The reason that the students do not have a better grasp on the science subjects is because medical education has become less homogeneous. Under the old system, the primary or science subjects were taken at the same time that the clinical ones were. The student thus gained an inkling of the relation of his science subjects to his clinical work. At the present time, this relation is not apparent to the student unless it is pointed out to him. The science years are becoming more and more divorced from the clinical, and the fact should be recognized and the tendency corrected.

From my study of the methods of instruction given in many of the medical schools, I believe that teachers of the science branches are largely to blame for this. That the science subjects should be taught by specialists is conceded by all, and they are rightly in charge of the years devoted to their subjects. They have had a hard fight to gain recognition and are hostile toward any movement to introduce into these years any clinical work, and many have gone so far as to insist that it is not their function to give any definite application to the subject. This has made necessary the introduction of applied courses in the different subjects to bridge the gap between the science and clinical years. Too often these courses when given have to be taught by teachers not connected with the science subjects. The science teachers, especially if engrossed in research work, are too apt to teach only the more scientifically interesting features and consider that they have done their duty when they have given the lecture courses of their subject, and leave to their assistants the more important laboratory instruction. The majority of these giving the laboratory courses are young and inexperienced teachers who have not had the advantage of a medical training, and their

only knowledge of the subject is that obtained in the pure science courses. If any question of application arises, they are unable to answer it and therefore discourage all such inquiries or resent them as "catch questions."

Teachers in the science branches should be in thorough sympathy with the future professional work of the students, and I am of the opinion that teachers in medical schools should have taken a complete medical course as part of their training. There are many eminent teachers in medical schools who have not had this training, but they have been long in contact with medical institutions and have a saving sympathy with the clinical side. In the large university schools and where the school is divided, there is danger in this lack of sympathy with clinical work, which attitude the science teachers are only too ready to criticize harshly in the clinical man if he does not show sufficient interest in their particular science.

Medical progress is being retarded by lack of coordination of science and clinical departments. The lack of training in clinical medicine too often prevents the science teacher from being of assistance to the clinician. Medical and surgical methods do not always fit in with laboratory technique. The complexity of the problem causes him to give little scientific value to the investigations not made in a laboratory. It is this attitude of the science teacher toward the introduction of clinical work or clinical methods in the first two years of the course, that is causing not only the student to fail to appreciate the value of and becoming interested in the subjects, but also to make him less able to apply the knowledge that he has gained of laboratory technique to his work in the clinic and wards. His *work* in the laboratory has been on frogs and the lower animals only. When he comes to his clinical years he finds that he can not use the apparatus with which he has become familiar to human beings. He finds new factors enter into the experiment which confuse his previously formed conceptions; he can not interpret his findings. The science teacher claims that this applied instruction should be given by the clinical teachers and also says that they should be competent to do it, which latter contention we grant, but what are the two years of instruction in the laboratories for but to prepare the student for his clinical work? Wherever possible methods and apparatus should be employed that can be used in clinical investigations. The burden of this instruction should not be thrown on the clinical years, already so overcrowded as to make a hospital year a necessity.

To insure a better correlation between science branches and clinical years and allow of unloading, the hard and fast lines that are tending to separate the second and third year of the course should be obliterated. As students come better prepared in the underlying sciences and are able to accomplish more in the same time, instead of extending the courses in pure science, correlated clinical laboratory courses should be introduced in the second year.

If the teaching staff of the science branches can not give these courses, then clinical teachers, most likely young men who have been trained in laboratory method, should give them. This would be the best introduction possible for the clinical subjects, and students so prepared could more rapidly advance in the third year. It would permit of omitting much of the lecture course in this year and allow an early contact with clinical material. To obtain such readjustment hearty coopera-

tion is needed from science and clinical teachers.

The establishment of state board examinations has been of great aid to medical education. It has raised the general standards of the profession, and secured a more uniform curriculum over the entire country. It has, however, had a decided influence on the overloading of the curriculum, as they have yoked the old methods with the new. The necessity for arranging the examinations to meet the training of graduates of years ago, as well as the recent, has been detrimental to progress and has encouraged cram-quiz book methods and put a premium on ability to answer questions, calling for mere detail information of the subjects. The time has come when state boards of examiners should recognize the changes that have occurred in methods of medical education; that the student who is best educated has not the best knowledge of small and unessential details; that to meet the requirements of the state boards he has to have recourse to quiz compends for much that is of no practical use to him. The new methods have been in force long enough to establish a class by itself and for licensing there should be one type for the graduate of former days and one for the more recent. As at present conducted, both in content and method, it is satisfactory to neither class. This association, by the cooperation of the Federation of State Medical Boards, could be of great value in correcting this defect. The state boards are appreciating this defect as well as medical educators, and would welcome any plan which would allow of a practical examination, both laboratory and clinical.

The difficulty in arranging such an examination is the lack of money and laboratory and clinical facilities. States with centers of medical education could easily get the facilities by holding the examinations in those places and using the college laboratories and clinics and hospitals. Different dates could be arranged for various sections. The states should consider that it is their duty to provide the necessary funds. That such a plan is feasible is shown by the ease with which large numbers of candidates for the positions of hospital interne are examined, both by written and practical examination.

Examinations have, and probably will be, the means of testing the character of instruction given by the medical schools and the knowledge of the students, but they should be adapted to give a true index. They must coordinate with the methods of instruction. At the present time they do not. Rating colleges according to the ability of students to pass these examinations is putting a premium on only such instruction as will enable the student to successfully meet the test. It is exalting narrow training over broad education. Evaluating bodies should not place too much value on the percentage of failures and passing as an index of instruction in the colleges.

From members of the general profession one constantly hears the harsh criticism that recent graduates are deficient in detailed knowledge of this or that specialty. That while skilled in laboratory methods of diagnosis, they have acquired little of the art of medicine. They insist that many new topics ought to be added to the course of study.

Much of the overburdening of the clinical years has been due to adding topics or extending courses in the special branches to meet these criticisms. The profession as a whole should appreciate that the student must, in his college course, gain his training in scientific methods if he is ever to have it. That only the essentials can be

taught thoroughly. Faulty training in the essentials is caused by trying to do too much. That only so much of the special branches can be given as to make them safe practitioners, not immature specialists.

It is desirable that every practitioner should know many things about his relation to society at large, to allied professions and their problems, to organize charities and their activities, and the business methods of his own profession. However, these topics should not be introduced into the medical curriculum, they are part of the postgraduate education, which every physician should feel it his duty to acquire.

The need of unloading and correlation is a most pressing one, and it is our duty as an association of medical colleges to point that way.

The complex question of a hospital or clinical year has been under discussion for some time by this and other associations. That the student needs more extended clinical experience before beginning the practise of his profession is conceded by all. There is not the same unanimity of opinion as to the advisability of making a clinical year obligatory or whether it should be demanded by the colleges for the degree of M.D. or by the states as a requirement for the right to practise.

Before a decision can be reached many administrative and pedagogic questions must be answered. As the necessary data have not been gathered, this association should cooperate with other bodies in making a collective investigation of the subject. As a large percentage of medical graduates now voluntarily take one or more years of hospital interneship I believe the first step should be to give both academic and legal recognition to this postgraduate training.

EGBERT LEFEVRE

UNIVERSITY AND BELLEVUE
HOSPITAL MEDICAL COLLEGE

THE PSYCHIATRIC CLINIC AND THE COMMUNITY [1]

THE increasing interest shown in the study of human activities is one of the most significant and hopeful signs of our times. Momentous as was the impulse given to science by Copernicus, Galileo and Newton one result of their investigations was to direct attention to a universe in which human beings were considered to be merely passive observers of natural phenomena. So absorbed did man become in formulating hypotheses to explain a theoretical universe of which he did not form a part, and in delving into the records of his own past history, he neglected the study of present activities. At last the course of events warned him that the lessons of remembrance or the hypertrophied historical sense had become "a malady from which men suffer."

The dedication of a psychiatric clinic is an event of more than ordinary importance to a community, as it marks the awakening of intelligent interest in man, as an active thinking being. Having striven for centuries to improve the methods for recording his fanaticisms, superstitions, sins of omission and of commission, and failures to adjust life to meet new conditions, he has begun at last to take rational measures to improve his lot, and to acquaint himself with the laws on which the social organism rests. As the value of this benefaction to the community will depend directly upon the intelligent use of resources and energy made available for rendering more effective service to humanity, may we not profitably devote a few moments in attempting to formulate some of the problems to the solution of which this clinic is dedicated. Errors in judgment committed now, in

[1] Address delivered at the opening exercises of the Henry Phipps Psychiatric Clinic, The Johns Hopkins Hospital, Baltimore, Md., April 16, 1913.

estimating the scope and the character of the investigations to be carried on in this building, might defeat the efforts of those upon whom the responsibility of equalizing opportunity and achievement must fall.

This clinic, in a peculiarly distinctive manner, typifies the human as well as the humane spirit of the twentieth century. During the seventeenth and eighteenth centuries the physical sciences had succeeded in breaking away from the traditions and superstitions which had hampered their development. Astronomy had been divorced from astrology, chemistry from alchemy, and the foundations of geology had actually been laid. In the nineteenth century the renaissance of the biological sciences was accompanied by the formulation and expression of a rational idea of man's position in cosmos. Towards the close of the eighteenth and the beginning of the nineteenth century a few investigators had already called attention to the importance of studying the activities of human beings; but not until the second half of the last century was there any realization of the fact that the most interesting phenomena of the universe for human beings to study were their own activities. How do we live, move and have our being?

To the lay mind the term psychiatry often suggests a very limited field in medical science, but those who take an active part in the work of this clinic will easily appreciate that they are engaged in attempting to find the solution of problems of far greater importance than any relating merely to the care of patients suffering from mental or nervous disorder. Anomalies of thought and conduct are studied in order that the knowledge acquired may be applied directly to making life for the majority of persons pleasanter and more effective. Institutions of this character are intended primarily for the study of human nature along broad biological lines.

We are justified in considering disease as an analytical process which reduces to a comprehensive form the complex activities we designate collectively as health. An intimate knowledge of abnormal states of mind and body is, as Pinel affirmed, a key that unlocks the secrets of human history. By making use of nature's contrast of functions we may also gain an insight into that continuous process of adjustment we call life. From the study of disease the facts have been gathered for the foundations upon which modern preventive medicine has been established, and through it a new meaning has been given to life and greater efficiency in thought and action to those who profit by the lessons of science. For centuries the different parts of the body have been studied by physicians, and a knowledge of the structure and function of the separate parts has been attained. It is essential, if we are to comprehend the fundamental mechanisms of response of the organism, that we familiarize ourselves with the laws which govern the relationship of all these organs as they are expressed in each individual, and we must accustom ourselves to study man as a living organism.

Living beings have the capacity of expressing their integral unity as individuals, and in the case of man there are special mechanisms of adjustment, collectively designated as the personality. The complex adjustments synthesized in the personality may easily be deranged by interference with the activities of organs or by disturbing the capacity for adaptation; the chief function of sense organs, brain and nervous system. We all know how intimately dependent human beings are upon their environment. Changes in the latter call for delicate and immediate adaptation, and it may be said the problems of psy-

chiatry relate to the determination of the causes which give rise to imperfect adjustments.

A great blessing was conferred by science upon humanity when the problems of psychiatry were restated in biological terms. Life was recognized as a process of adjustment, relatively perfect in health and imperfect in disease; while that metaphysical term insanity arbitrarily reserved to designate certain forms of unsuccessful adjustment was cast into the rubbish-heap together with the chains, straight-jackets and hand-cuffs which had long tortured the lives of patients. Out of hazy mystical conceptions entertained in regard to the nature and genesis of activities described as thought and conduct sprang new ideas potent to inspire the minds of investigators, capable not only of bringing about great practical reforms in the care of the insane, but also in improving the methods for attacking the problems relating to human thought and conduct.

As the ultimate success of the work to be carried on in this clinic, more than in any other department of the hospital, will depend upon cooperative endeavor, I may be permitted to emphasize what seems to me to be an important factor in organization and administration. The patients presenting themselves for treatment are subjects of imperfect adjustments in the life process. The time during which they remain under observation in these wards will represent relatively brief epochs of life, and the records of cases will often give but cursory glimpses into the genesis, duration and progress of imperfect life adaptations. In order to serve the high purpose for which it is planned and dedicated this clinic should be regarded as an important link in a chain of agencies, home, school, college, other hospitals and institutions; in fact the entire social organization with which it is essential constant sympathetic contact should be maintained. Only by the establishment of these relationships can progress in the study of life processes be made.

May we express the hope that in attempting to estimate the value of the work accomplished in this clinic the public expression of opinion should be tempered by charity and patience. Although the field of investigation, which includes the consideration of the factors determining human thought and conduct is the most interesting one in modern medicine, let us not forget that it is the last one to be thrown open to investigators.

The methods of investigation necessarily employed will not appeal to the imagination of the public. The inspiration essential to solve the problems of modern psychiatry will probably not flash into consciousness as did the visions that guided the observer watching the lamps swing in the cathedral or the apple fall from the tree, but it will come gradually only after patient quiet effort, similar to that which finally rewarded the author of "The Origin of Species," and gave a new meaning to life. The realization of the ideals to which we do homage to-day will mark the time when, in Goethe's words,

> Vernunft fängt wieder an zu sprechen,
> Und Hoffnung wieder an zu blühn.

STEWART PATON

TENTH INTERNATIONAL VETERINARY CONGRESS

THE organizing committee of the Tenth International Veterinary Congress to be held in London, August 3 to 8, 1914, made a strong appeal to the veterinary profession of the different countries to organize national committees as early as possible in order that an appropriate propaganda may be carried on for the congress, and thereby a large attendance assured.

In view of this and the consideration that the annual meeting of the American Veterinary Medical Association will not take place until September, 1914, it was deemed advisable to organize without delay a national committee for the United States. At the advice of Dr. John R. Mohler, president of the American Veterinary Medical Association, Dr. L. Van Es, who was the official representative of the Ninth International Veterinary Congress at The Hague, was asked to accept the chairmanship, to which he willingly consented, at the same time requesting me to act as the secretary of the national committee.

Dr. Van Es named the following vice-presidents for that committee: Dr. A. D. Melvin, Washington, D. C.; Dr. K. F. Meyer, Philadelphia, Pa.; Dr. C. J. Marshall, Philadelphia, Pa.; Dr. J. R. Mohler, Washington, D. C.; Dr. J. Hughes, Chicago, Ill.; Dr. W. H. Dalrymple, Baton Rouge, La.; Dr. E. C. Schroeder, Washington, D. C.; Dr. V. A. Moore, Ithaca, N. Y.; Dr. E. C. Cotton, Minneapolis, Minn.; Dr. J. S. Anderson, Seward, Nebr.; Dr. S. Brenton, Detroit, Mich.; Dr. C. A. Cary, Auburn, Ala.; Dr. D. S. White, Columbus, Ohio; Dr. S. B. Nelson, Pullman, Wash.; Dr. M. Francis, College Station, Texas; Dr. W. F. Crewe, Devils Lake, N. Dak.

With the organization completed, the committee now desires to commence their work and to create a wide interest among the veterinarians of the United States, thereby securing a creditable delegation from our profession.

Sir Stewart Stockman, honorary secretary of the organizing committee, in a letter addressed to Dr. A. D. Melvin, expressed his desire to obtain at an early date the names of those who desire to act as reporters for the various subjects to be discussed at the congress, also at the same time enclosing a copy of the list of subjects which are to be discussed at the Tenth International Veterinary Congress. The list is prepared as follows:

GENERAL MEETINGS

1. Foot and mouth disease.
2. Tuberculosis, including the relationship of the so-called types of tubercle bacilli.
3. Epizootic abortion.
4. Public control of the production, distribution and sale of milk in the interests of public health.

Section I.—Veterinary science in relation to public health.

1. Meat poisoning—its pathogenesis and the measures necessary to guard against it.
2. General principles to be observed in the inspection of the carcasses and organs of tuberculous animals with a view to determining their safety as articles of human food.
3. Disinfection of wagons.

Section II.—Pathology and bacteriology.

1. Johne's disease.
2. Bovine piroplasmoses (European), with special reference to their etiology.
3. Ultra-visible viruses.
4. Distemper—etiology and vaccination.

Section III.—Epizootiology.

1. Anthrax.
2. Swine fever.
3. Glanders.
4. Sarcoptic mange of the horse.

Section IV.—Veterinary medicine and surgery.

1. Anesthesia—local and general.
2. Laminitis.
3. The surgical treatment of roaring.
4. The use of drugs in the treatment of disease caused by nematode worms.

Section V.—Tropical diseases.

1. Diseases transmitted by ticks; their classification, treatment and prevention.
2. Diseases transmitted by winged insects; their classification, treatment and prevention.

It is also planned to arrange in connection with the Tenth International Veterinary Congress a study tour for veterinarians, under the auspices of the Bureau of University Travel, the itinerary of which will include a trip through Belgium, France, Switzerland, Italy, Hungary, Austria, Germany, Holland and England, thereby affording the veterinarians desiring to attend the congress a splendid opportunity of studying all phases pertaining to veterinary medicine in the different countries.

Such a tour will be the first undertaken by a body of veterinarians from this country and would afford splendid advantages to members of the profession, affording not only pleasurable but also educational advantages; be-

sides such a body would receive exceptional courtesies from the authorities abroad.

It is only natural that a competent director of the tour will be named who, with extensive experience in travel abroad and a knowledge of languages, will be in position to care for the welfare of the party in the best possible way.

It is hoped that the members of the profession will aid the committee in its work. Those who desire further information will be given full attention.

ADOLPH EICHHORN,
Secretary

SCIENTIFIC NOTES AND NEWS

THE Paris Academy of Sciences has elected Professor W. M. Davis, of Harvard University, a correspondent in the Section of Geography and Navigation, in the place of the late Sir George Darwin.

THE University of California has awarded an honorary degree to Mr. John Muir, "born in Scotland, reared in the University of Wisconsin, by final choice a Californian, widely traveled observer of the world we dwell in, man of science and of letters, friend and protector of nature, uniquely gifted to interpret unto other men her mind and ways."

THE Halle Academy of Sciences has awarded its gold Cothenius medal to Dr. Leonhard Schultze, professor of geography at Marburg.

DR. OTTO H. TITTMAN, chief of the Coast and Geodetic Survey, has been made an honorary member of the Berlin Geographical Society.

THE Hanbury medal of the Pharmaceutical Society, London, has been awarded to Dr. Frederick Bilding Power, Ph.D., LL.D. The medal is awarded bienially for original research in the chemistry and natural history of drugs. Dr. Power, who is director of the Wellcome Research Laboratories, London, is an American by birth.

THE council of the Royal Society of Arts has passed the following resolution:

On the occasion of the fiftieth award of the Albert medal of the Royal Society of Arts, the council of the society desire to offer the medal to H.M. King George V., for nine years president, and now patron of the society, in respectful recognition of his Majesty's untiring efforts to make himself personally acquainted with the social and economic condition of the various parts of his dominions, and to promote the progress of arts, manufactures and commerce in the United Kingdom and throughout the British Empire.

THE gold Nachtigall medals of the Berlin Geographical Society have been awarded to Duke Adolf Friedrich, of Mecklenberg, and Professor Hans Meyer, for explorations in Africa.

PROFESSORS J. L. COOLIDGE, E. V. HUNTINGTON and G. D. BIRKHOFF, of the division of mathematics of Harvard University, have been elected to membership in the American Academy of Arts and Sciences.

THE Rumford Committee of the American Academy, at its last meeting, voted the following appropriations: to Frederick G. Keyes, of the Massachusetts Institute of Technology, $300 to be used for the payment of assistants in the computation of thermodynamic tables for ammonia, and to Professor Theodore W. Richards, of Harvard University, $100 to be used in aid of the publication of the Annual International Tables of Constants.

SECRETARY LANE has announced a reorganization of the reclamation service. F. H. Newell, director of the Reclamation Service, will be chairman of a new Reclamation Commission. The commission will consist of five members, who, besides Chairman Newell, will be George Barton French, in charge of operation and maintenance; A. P. Davis, chief engineer; Judge Will R. King, of Oregon, chief counsel, and one other, who will have charge of the contracts and finances.

DR. W. D. BIGELOW, for many years a member of the Bureau of Chemistry, U. S. Department of Agriculture, has resigned from the government service to take charge of the laboratory of the National Canners' Association to be established in Washington.

MR. NATHAN C. GROVER, of New Jersey, has been appointed chief hydraulic engineer of the water-resources branch of the U. S. Geological Survey, to succeed Mr. Marshall O. Leighton, who resigned early in May to plan and supervise land drainage in Florida.

MR. C. G. ELLIOTT, chief of drainage investigations in the Department of Agriculture, has left the government service to go into private business.

MR. E. N. WENTWORTH, associate professor of animal husbandry at the Ohio State College, has become associate editor of *The Breeders' Gazette*.

DR. T. N. CARVER, David A. Wells professor of political economy at Harvard University, has been appointed director of the Rural Organization Service, a new branch of work just organized by the federal Department of Agriculture, and has been granted leave of absence from the university so that he may be able to carry on the new work he has undertaken.

MR. L. F. RICHARDSON, assistant lecturer in physics at the Municipal School of Technology, Manchester, has been appointed superintendent of the Geophysical Observatory, Eskdalemuir, in succession to Mr. G. W. Walker, resigned.

MR. T. L. ECKERSLEY, B.A., of Trinity College, Cambridge, has been appointed assistant at the Helwan Observatory, Egypt, to assist in the magnetic work.

PROFESSOR VON DUNGERN, of Heidelberg, has been appointed director of the newly established institute for experimental cancer research at Hamburg-Eppendorf.

DR. W. A. MURRILL, assistant director of the New York Botanical Garden, has sailed for Europe to study especially the conditions of the growth of trees in cities.

THE Academy of Science of Oregon has elected officers as follows:

President—N. H. Laurie.
First Vice-president—A. R. Sweetzer.
Second Vice-president—T. D. Beckwith.
Third Vice-president—W. L. Finley.
Secretary—Miss Jane Stearns.
Treasurer—A. L. Knisley.
Librarian—A. W. Miller.
Trustees—A. L. Knisley, E. A. Beals, J. D. Lee.

THE results of the election for the Ohio State University Chapter of the Sigma Xi Society was as follows:

President—C. S. Prosser, professor of geology.
Vice-president—John F. Lyman, professor of agricultural chemistry.
Secretary—W. M. Barrows, instructor in biology.
Treasurer—John A. Wilkinson, assistant professor of chemistry.

THE Minnesota Chapter of the Sigma Xi met on May 29 for its annual banquet and initiation of new members. At the same time researches of three of the initiates was presented as follows:

"A Successful Case of Applied Entomology," C. W. Howard.

"Parasitism in Rusts," E. C. Stakman.

"Sunlight as a Factor in Plant Metabolism," R. W. Thatcher.

At Minnesota, research is essential for the election to Sigma Xi.

DR. JAMES W. JOBLING, of Michael Reese Hospital, Chicago, Ills., gave the annual address before the Minnesota Pathological Society on May 20. His subject was "The Toxicity and Antigenetic Properties of the Cleavage Products of Bacterial Proteins."

PROFESSOR G. H. PARKER, of Harvard University, addressed the Brown Chapter of Sigma Xi, at the University Club, Providence, on May 28, on a "Biological Forecast."

PROFESSOR G. W. PIERCE, of Harvard University, has delivered three lectures on "Wireless Telegraphy and Wireless Telephony" before the student officers of the post-graduate department of the United States Naval Academy at Annapolis, Md.

A LARGE bronze mural tablet to the memory of the late Dr. John Herr Musser, professor of clinical surgery in the University of Pennsylvania, has been presented to the University Hospital. The tablet was designed by Dr. R. Tait McKenzie.

LORD AVEBURY, formerly Sir John Lubbock, distinguished for public services in many di-

rections, including a large number of contributions to natural science and books of popular interest, died on May 28, aged seventy-nine years.

Dr. Max Thomas Edelmann, professor of physics in the School of Technology of Munich, has died at the age of sixty-eight years.

Dr. H. Weber, professor of mathematics at Strassburg University, died on May 17, at seventy-one years of age.

M. Alfred de Foville, permanent secretary of the Académie des Sciences Morales et Politiques, an eminent economist and statistician, has died at the age of seventy-one years.

The death is announced of Friedrich Wilhelm Ristenpart, director of the Observatory at Santiago, Chili.

The U. S. Civil Service Commission announces an examination for soil biochemists at salaries ranging from $1,800 to $2,200 a year, in the Bureau of Soils, Washington, D. C.

The Canadian Medical Association will hold its forty-sixth annual meeting in London, Ontario, on June 24, under the presidency of Dr. H. A. McCallum.

The American Medical Association will hold its sixty-fourth annual session at Minneapolis from June 17 to 20, under the presidency of Dr. John A. Witherspoon. The work of the meeting will be distributed among the following sections: The practise of medicine, surgery, obstetrics, gynecology and abdominal surgery, ophthalmology, laryngology, otology and rhinology, diseases of children, pharmacology and therapeutics, pathology and physiology, stomatology, nervous and mental diseases, dermatology, preventive medicine and public health, genito-urinary diseases, hospitals and orthopedic surgery.

A tidal observatory, the first of its kind in Great Britain, erected near the Castle, Dunbar, has been opened. One of the main objects of the observatory will be to afford a means of examining local vertical movements of the coastline, if any occur, as recommended by the royal commission on coast erosion.

The Nathan Lewis Hatfield prize of the College of Physicians of Philadelphia, amounting to $500, will be awarded in 1916. The deed of trust requires that the prize shall be on a subject of general medicine, medical pathology or therapeutics, the treatment to embody original observations, or researches, or original deductions. Competition for the prize is open to the medical profession and men of science in the United States. The original of the successful essay becomes the property of the College of Physicians. All manuscripts must be sent by May 30, 1915, to the committee, which consists of William G. Spiller, M.D. (chairman), Allen J. Smith, M.D., and William Pepper, M.D.

An association, called the Union Médicale Franco-Ibéro-Américaine, has, as we learn from the *British Medical Journal*, recently been formed in Paris for the purpose of uniting the doctors of the republics of Central and South America with Spanish and French physicians in a scientific alliance of Latin races. From the initial letters of its title it is called for shortness "Umfia." The president is Dr. L. Dartigues; the general secretary is Dr. Gaullier l'Hardy; the vice-presidents, Drs. Bandelac de Pariente (physician to the Spanish embassy in Paris), Manrique and Delaunay. Among the members of the honorary committee are the Spanish ambassador to the French republic; Professor Ortega Morejon, member of the Spanish Academy of Medicine; Dr. Pulido, senator of Spain; Dr. Risquez, sometime rector of the University of Caracas, together with the dean of the Paris Faculty, Professor Landouzy, and Professors Ch. Richet, F. Widal, A. Robin, Pozzi, Pierre Marie, Pinard, Legueu, Doléris and Bazy, and Dr. Roux, director of the Pasteur Institute. Membership is open to all doctors throughout the world who speak Spanish or Portuguese. At present there exist more than twenty autonomous nations of Spanish speech, and it is estimated that the language is spoken

by more than a hundred million persons. It is propesed to estabish a Hispano-American Hospital, to arrange scientific tours and to make summaries of all medical papers written in Spanish available for members. The objects of the Umfia are to make its members known to each other, to establish relations, social and scientific, with the doctors of every country where Spanish is spoken; to establish an information bureau for Spanish or Portuguese doctors who go to Paris to pursue clinical work and research; to arrange courses of instruction, lectures, meetings, festivities and congresses, and to organize means of assistance to foreigners of Spanish-American origin settled in Paris who may be in need of help.

WE learn from *Nature* that the famous prehistoric camp, known as Maiden Castle, near Dorchester, has been, at the suggestion of King George, purchased by the Duchy of Cornwall, and will now be carefully preserved. The camp dates from Celtic times, and formed a shelter for cattle during tribal raids rather than a military fortress. Water was supplied from a neolithic dew-pond on the summit of the plateau, and the palisading kept at bay wolves and other enemies, while the cattle were left in charge of a few women and children. The cunningly arranged entrances to the camp supply a remarkable example of primitive methods of defence.

UNIVERSITY AND EDUCATIONAL NEWS

THE special state appropriation bills for the University of California, as signed by the governor, provide amounts as follows: support and maintenance of the university, \$400,000; agriculture (support and maintenance of all branches), \$700,000; New North Hall, \$400,000; impairment of income, \$62,000; replacement of buildings and equipment at Lick Observatory, \$50,000; university extension, \$50,000; Los Angeles medical department (support), \$20,000; Los Angeles medical department (new buildings), \$25,000; Scripps Institution for Biological Research, \$15,000; printing, \$12,000; one dormitory at Davis, \$40,000; dining hall at Davis, \$10,000; classroom and library buildings at Davis, \$65,000; small buildings at Davis, \$20,000; 200 acres for experiment station in southern California, \$60,000; laboratory building for experiment station in southern California, \$100,000; residence, barns, etc., for experiment station in southern California, \$25,000; total special appropriations, \$2,054,000. To these appropriations there must be added the state university fund to be automatically appropriated during the coming two years for the support and maintenance of the university amounting in total to \$1,802,978. The grand total appropriated by the state of California for the University of California for the next biennium is therefore \$3,856,978.

YALE UNIVERSITY will receive \$475,000 from the estate of Dr. Francis Bacon, who died last year. The sum will be available for almost immediate use.

MRS. MARY EMERY has contributed \$125,000 to the Ohio-Miami Medical College of the University of Cincinnati for the endowment of a chair of pathology. A sum of about \$80,000 from the estate of Dr. Francis Brunning has also been received by the university, the income of which will be used for the endowment of a second chair.

THE general faculty of Oberlin College has voted to recommend to the trustees that this year all honorary degrees be omitted at commencement.

MR. KERR DUNCAN MACMILLAN, assistant professor of church history in the Princeton Theological Seminary, has been elected to the presidency of Wells College.

DR. JAMES H. WOODS has been promoted to be professor of philosophy at Harvard University.

DR. CHARLES AUGUSTUS TUTTLE, professor of political economy and political science at Wabash College, Crawfordsville, Ind., has been elected professor of economics and social science at Wesleyan University.

Dr. J. Argyll Campbell, junior assistant to Professor Schäfer at Edinburgh University, has been appointed professor of physiology in the University of Singapore.

W. Dawson, M.A., D.Sc. (Agr.), has been appointed to succeed Mr. A. Henry as reader in forestry at Cambridge University. Mr. Dawson has held a similar position at Aberdeen University.

Professor Strasburger, of Breslau, has accepted the position of director of the newly-established medical policlinic and therapeutic course at Frankfort-on-the-Main, which are to be considered a department of the proposed university.

Professor Kaiserling, of Berlin, has accepted the appointment as successor of Professor Henke at the Cologne Institute of Pathology.

DISCUSSION AND CORRESPONDENCE

TYPES OF SPECIES IN BOTANICAL TAXONOMY

It is becoming more and more evident that only by the use of the method of types[1] can any stability be secured in taxonomy. In spite of a growing realization of this fact there has been no adequate appreciation on the part of botanists of the great advantages offered by plants over animals in the facilities they afford for the multiplication of type material.

Primary Types

Although the author of a new species usually has at his disposal several different specimens upon which he bases his description, nevertheless only a single twig or shoot together with any organs borne on it can be considered to be the true type specimen. It is not permissible to accept as parts of the type other twigs or stems, for it often happens that they were not collected from the plant that yielded the true type specimen and subsequent research may show them to belong to a different variety or even to a different species. Experience has shown that the author of a species is far from infallible, and that to accept his verdict on this point may give rise to a complete misunderstanding of the species on the part of later investigators and cause endless confusion in the subsequent literature.

Even in case of diœcious or polymorphous plants where it is obviously impossible for a single specimen to represent all of the essential characters of the species, the twigs cut from different forms are not to be considered as parts of the type specimen. It is easy to see that where several species occur in the same region it is not always possible for the author of the species to be sure that the different sexes or castes[2] represented in the material at his disposal really belong to one and the same species. It is necessary to designate some one specimen as the type and to associate with it as paratypes additional specimens of the other sex or of the other castes that seem undoubtedly to belong to the same species Usually the pistillate specimen will be designated as the type.[3]

Even in case of a number of specimens presumably cut from the same plant it is unsafe to consider more than one of them as the type since there is always the chance that two plants growing close together were not distinguished. Abnormalities or bud variations on the type plant might also be overlooked, particularly if the collector, not realizing that he was dealing with a new species, exercised no unusual care.

The type specimen is therefore unique, and can not exist in duplicate. Types are the

[1] Cook, O. F., 1898, "The Method of Types," in Science (N. S.), 8: 513–516, No. 198, October 14. Cook, O. F., 1900, "The Method of Types in Botanical Nomenclature," in Science (N. S.), 12: 475–481, No. 300, September 28.

[2] Cook has discussed in some detail the various castes of plants having definitely specialized heterism (ropism). Cook, O. F., 1907, "Aspects of Kinetic Evolution," in *Proceed. Wash. Acad. Sci.*, 8: 369–378, February 13.

[3] The term allotype, although proposed for paleontological material, might very properly be applied to any paratype possessing some very important organ or distinctive feature not present in the type itself. Burling, Lancaster D., 1912, "The Nomenclature of Types," in *Journ. Wash. Acad. Sci.*, 2: 519–520, No. 21, December 19.

most valuable possession of museums and constantly increase in value as years elapse. They should not be left in the herbarium with the ordinary specimens, but should be so mounted as to be protected from injury in handling[4] and should be kept in fire-proof cases, if possible in a special room where they may be consulted in the presence of a custodian who can help to preserve all fragments of the type material.

The type plant from which the type specimen was secured has a far greater importance than a type animal. Very often additional specimens almost exactly duplicating the type can be secured from it. These are merotypes[5] and if used by the author of the species in drawing up the original description become paratypes as well. Carefully selected merotypes collected at the same time as the type specimen and used by the author as paratypes are, properly speaking, duplicate types, having practically the same value from a taxonomic standpoint as the type itself, and should receive the same treatment in museums.

If the original type is lost during the life of the author of the species it is often possible to secure substitute types collected from the very spot where the type was secured. It is sometimes possible to secure merotypes from the plant that yielded the original type. As a rule no such satisfactory substitute types can be obtained after the death of the author of the species.

Besides merotypes proper, cut from the type plant as it stands, it is often possible to secure specimens from its vegetatively propagated offspring. Such clonotypes,[6] as they have been called, may be secured from plants that reproduce naturally by bulbs, offshoots, tubers, etc., as well as from those propagated artificially by grafts or cuttings. Clonotypes can thus be obtained in unlimited numbers and are usually only slightly less representative than merotypes proper.

Specimens taken from seedlings of the type plant have been called spermotypes. They are of interest in case of short-lived species too small to furnish many merotypes and unable to yield clonotypes. Such seedlings if compared with the type and found to agree with it in all essential characters yield spermotypes almost as representative as clonotypes or merotypes. Spermotypes of diœcious or polymorphic species have unusual value since the seeds obtained from the female plant that yielded the type specimen can usually be depended upon to reproduce the species unchanged, with of course both the constituent sexes or all the polymorphic forms represented among the seedlings.

Reproduced Types

Besides the additional material obtained through the subdivision of the type plant or by its propagation vegetatively or from seed there are other important means for the wide distribution of type material.

Photographs may be taken of the type specimens and, inasmuch as the camera is able to reproduce all the detail visible to the unaided eye and does it mechanically, these phototypes,[7] as they have been called, are of much value, especially as they can be reproduced indefinitely.

Phototypes are rendered still more valuable if they can be supplemented by a fragment of the type taken from a position definitely marked on the photograph. Such specimens have been called clastotypes. They can have, of course, only a limited distribution, since very few fragments can be spared from a type specimen.

[4] Kellerman, Maude, 1912, "A Method of Preserving Type Specimens," in *Journ. Wash. Acad. Sci.*, 2: 222–223, No. 9, May 4.

[5] Swingle, Walter T., 1912, "Merotypes as a Means of Multiplying Botanical Types," in *Journal Wash. Acad. Sci.*, 2: 220–222, No. 9, May 4.

[6] Swingle, Walter T., 1912, "Clastotypes, Clonotypes and Spermotypes, Means for Multiplying Botanical Type Material," in the *Journal Wash. Acad. Sci.*, 2: ~~337–339~~, No. 14, August 19. 344-348

[7] Kellerman, Maude, 1912, "Phototypes, Means for Wide Distribution of Type Material," in *Journal Wash. Acad. Sci.*, 2: ~~339–40~~, No. 13, August 19. 346-348

A representative merotype properly authenticated may be illustrated by nature prints, discovered by Auer and Worring and so beautifully applied by Ettinghausen and Pokorny,[8] whereby all the minute details of venation are shown in exact mechanical reproduction, and an indefinite number of copies can be made for distribution. This method, marvellous as it is, can not be used for the type itself, as the specimen may be destroyed or at least injured in the process of making the plate.[9]

Such a nature print, for which the term piesmotype[10] is suggested, is eminently adapted for the reproduction of an authentic merotype. This piesmotype, together with a phototype, gives an authentic, unbiased and very vivid picture of the type of the species.

Finally, in case of cones, nuts, or other organs showing relief sculpture, casts may be taken; these are the plastotypes of Schuchert.[11] They are probably of greatest value in reproducing types of fossil plants, although they can be made from almost any glabrous plant organ.

Syntypes and Paratypes

If, as is usually the case, several specimens from distinct plants and often from different localities are used by the author in describing his species the type material belongs to one of two categories. Either the author did not directly or indirectly designate a type and therefore all the specimens are syntypes,[12] or a type was designated, in which case the other specimens studied by the author are paratypes.[13]

What are here called syntypes are also known as cotypes,[14] but unfortunately the latter word is also very commonly, though erroneously, used to designate paratypes. In earlier times when the author of a new species rarely designated a type all of the specimens were very properly known as cotypes. It was easy to continue to apply the name to the specimens, even when the author had designated one of them as a type. Such a practise leads to confusion and should be abandoned, and a more precise and definite terminology used.

Although syntypes are usually segregated sooner or later into a type (lectotype[15]) and paratypes, it is nevertheless important to avoid any confusion in type material such as is likely to result from using the term cotype. It would, indeed, be better to abandon altogether the word cotype.

The rules that have been formulated for the typification of species, particularly those given in the American code of botanical no-

[8] Ettingshausen, C., and Pokorny, A., 1856, "Physiotypia plantarum austriacarum. Der Naturselbstdruck in seiner Anwendung auf die Gefässpflanzen des oesterreichischen Kaiserstaates." F°, 5 vols., Wien.

[9] The thoroughly dry herbarium specimen is forced into a plate of soft lead by great pressure exerted by a slow-moving roller, then an electrotype is made in hard metal from the lead original and impressions are made from the electro as is done from an engraved copper plate.

[10] Piesmotype (πιεσμός, pressure; τύπος, type); a picture printed from a plate bearing an imprint made by mechanical means from an authentic merotype.

[11] Schuchert, Charles, 1897, "What is a Type in Natural History," in SCIENCE (N. S.), 5: 636–640, No. 121, April 23.

[12] [Bather, F. A.], 1894, "Scientific Volapuk," in *Natural Science*, 4: 57, No. 23, January.

[13] "A *para-type* is a specimen belonging to the original series, but not the type, in cases where the author has himself selected a type. It should, however, be one of the specimens mentioned or enumerated in the original description." Thomas, Oldfield, 1893, "Suggestions for the More Definite Use of the Word 'Type' and its Compounds as Denoting Specimens of a Greater or Less Degree of Authenticity," in *Proc. Zool. Soc.*, 1893, p. 242, Pt. 2, No. 17, August 1.

[14] "A *co-type* is one of two or more specimens together forming the basis of a species, no *type* having been selected. No species would have both type and co-types, but either the former, or two or more of the latter." Thomas, Oldfield, *l. c.*

[15] Schuchert, Charles, in Merrill, Geo. P., 1905, Catalogue of the Type and Figured Specimens of Fossils, Minerals, Rocks and Ores in the Department of Geology, United States National Museum, Bull. 53, Part I., Fossil Invertebrates, p. 12.

menclature, suffice in very many cases to determine which of the syntypes is to be made the lectotype.[18]

Supplementary Typical Material

Besides the type material proper there are the so-called supplementary types (plesiotypes) and typical specimens (topotypes, etc.) which have been treated in detail by Schuchert. These need not be considered here, as they are merely specimens judged, with more or less show of reason, to be like the type. Often, perhaps usually, they do not belong in the type collection at all.

To summarize briefly the different kinds of type material we have:

I. *Type Material Proper*

1. Primary types, specimens used by the author in describing a new species, including either (*a*) the true *type* (with its *clastotypes*) and *paratypes*, or (*b*) the *syntypes*.

2. Additional types, specimens taken from the type plant or from its offspring, including *merotypes*, *clonotypes* and *spermotypes*.

3. Substitute types, specimens selected as types when the type was not designated, including *lectotypes*.

4. Reproduced types, mechanical reproductions of types, including *phototypes*, *piesmotypes* and *plastotypes*.

II. *Supplementary Typical Material*

5. Supplementary types, specimens used as a basis for descriptions or figures of previously published species, *plesiotypes*.

6. Typical material, specimens (from the type locality if possible) considered to be like the type, *topotypes*, etc.

WALTER T. SWINGLE

MOSQUITOES POLLINATING ORCHIDS

EARLY in July, 1912, Miss Ada K. Dietz, who was doing research work in plant ecology at the University of Michigan Biological Station at Douglas Lake, told me that she had seen in Rees's Bog a mosquito bearing on its head two small yellow masses that looked like pollen. I went to the bog and found many mosquitoes there. In a few minutes I had caught a half dozen or more, all of them females, bearing the yellow masses. On closer examination these proved to be pollinia of the orchid, *Habenaria obtusata* (Pursh.) which was at that time abundant in the bog and in full bloom. Most of the mosquitoes carried one pollinium, some had two or three, and one had four pollinia attached to its eyes.

This orchid is small, green and inconspicuous, but very similar in the structure of its flower to *Orchis mascula*, described by Darwin in his book on the "Fertilization of Orchids," and by Müller in "The Fertilization of Flowers." Also, the complex process of pollination as described in the last named book (p. 535) for *O. mascula* might apply almost unchanged for *H. obtusata* with mosquitoes instead of bees for the pollen-bearers.

I gathered a number of the plants and a few mosquitoes that were free from pollinia and put them together in a glass aquarium jar. In a few days the mosquitoes had removed most of the pollinia from the flowers and now bore them on their eyes exactly as had those caught outside.

I did not learn the name of the mosquito concerned. It was probably not *Culex pipiens*, which is mentioned by Müller as a visitor to the flowers of *Rhamnus Frangula*. So far as I know, this is the only case reported in which mosquitoes seem to be of primary importance as agents of pollination.

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SCIENTIFIC BOOKS

The New Realism: Cooperative Studies in Philosophy. By E. B. HOLT, W. T. MARVIN, W. P. MONTAGUE, R. B. PERRY, W. B. PITKIN and E. G. SPAULDING. New York, The Macmillan Company. 1912.

The World We Live In. By GEORGE STUART FULLERTON. New York, The Macmillan Company. 1912.

The first of these contributions to philos-

[18] Arthur, J. C., et al., 1907, "American Code of Botanical Nomenclature," in *Bull. Torrey Bot. Club*, 34: 172–174, No. 4, April, published June 11.

ophy should have a somewhat exceptional interest for men of science. For it makes use of data drawn from the special sciences more than is the wont of philosophical books; it represents an attempt to introduce something more closely resembling the scientific method and temper into philosophical inquiry; and it is chiefly devoted to the establishment of a conclusion which, if accepted, would apparently necessitate the relinquishment of certain modes of thought and speech frequently used in the interpretation of the methods and results of scientific observation. In the spirit and procedure of the authors there is much that is both rare and laudable. Real, organized cooperation in philosophizing—the provisional segregation of definite questions, and an attempt to reach a collective answer to them by methods which have borne the test of open discussion at close quarters and of repetition by other inquirers—this is still a sadly unaccustomed practise among philosophers; there are even those who deem it impossible and of dubious desirability. Whatever else they have done, the six authors of "The New Realism" have in this matter set the philosophical world an example which it is to be hoped will be not only praised but imitated. Nor is it only in their cooperation that they have carried over the temper of science into the business of the philosopher. The book for the most part is singularly free from those *arrière-pensées* which often vitiate, even though they enrich and make more humanly interesting, philosophic reflection. There is almost no trace of the desire to edify, no great solicitude as to the immediate bearing of their results upon "life," no tendency to confuse philosophy with either poetry or preaching. The writers seem desirous merely of reaching a verifiable conclusion upon a specific issue. With complete intellectual detachment they can not, indeed, quite be credited; they have, after all, a *parti pris*, and at least one of the six writes much in the style and spirit of the special pleader. But since they have a common cause to sustain, the openness with which they acknowledge its initial difficulties and disclose their inability to agree upon a common solution of those difficulties, is the more admirable. One's admiration would, indeed, have been still greater if this had led to an actual suspension of judgment upon the main issue, as the final result of the cooperative effort—which, as will appear, is the result towards which, at most, the course of the argument would seem to point. But this, perhaps, is more than it would be reasonable to expect. Even as it is the book is an almost unique example of a genuine and persistent attempt at close thinking *together*—at a literally "dialectic" process—on the part of a considerable number of philosophers, of whom none stands in the relation of master to the others.

The point in the "new realism" which constitutes both its novelty and its chief significance for natural science is, not its realism, but its doctrine about consciousness. For that doctrine, if accepted, entails the abandonment of certain conceptions still extensively used by science as well as by common sense. It has been, moreover, the generating principle of the whole theory, from which all of its principal conclusions and most of its characteristic difficulties have arisen. It is the more important to recall this fact because, while this theory of consciousness clearly underlies much of the reasoning in the volume, it is not altogether definitely and connectedly stated here (though it has been so stated in previous writings of some of the group), and it seems at times to be forgotten altogether.

The doctrine in question is this: that what is commonly called "consciousness" is simply a particular mode of relation; and that it is an "external" relation, *i. e.*, one which does not constitute or in any way alter the terms which at any time happen to enter into that relation. From this doctrine follow directly the two essential articles in the new realism's account of the nature of the transaction called sense-perception—its affirmation, at once, of the "independence" and of the "immanence" of the object perceived. Given the conception of consciousness as merely an otiose relation among items totally unaffected thereby, and

the object necessarily must be independent; for such a relation is not a thing upon which anything *could* depend. No less obviously must the object be immanent; *i. e.*, must at the time of perception be "numerically" and in all other respects identical with the percept. For there is nothing in an external relation which could produce duplicates or "images" of the terms related. Thus the root-doctrine of this new philosophy is "the relational theory of consciousness," which branches out into the two derivative doctrines of realism and epistemological monism (*i. e.*, the doctrine that object and idea or percept are one identical entity). Not only does it produce these secondary conclusions; it apparently provides their chief support. I, at least, am unable to find in the volume much *positive* argument (as distinct from proofs of the inconclusiveness of certain arguments of idealism and dualism) for the object's independence and immanence, except deductions from the relational theory of consciousness. Upon the validity of this theory, then, the constructive part of the new realism depends. I shall accordingly limit the present examination of this collection of reasonings to two questions: (1) What positive reasons are offered for the opinion that consciousness is merely an external relation? (2) How do the new realists meet the usual arguments—not of idealism, but of common sense—for the view that consciousness can not possibly in all cases be an external relation, that, in other words, *some* content of consciousness must be regarded as existing only in and by means of consciousness?

1. With regard to the first point, one must first of all complain that the relational theory of consciousness is left, in two important respects, in great obscurity. It still remains difficult to determine just *what kind* of relation *to* what, the consciousness-relation is supposed to be. So far as the authors approach definiteness upon this, they also seem to diverge from one another. But I do not here wish to dwell upon this consideration. More serious is the uncertainty in which the reader is left with respect to another question. Is consciousness held to be *wholly and in all cases* non-constitutive of the content that is in consciousness? Does the new realism mean to reject the notion of "purely subjective existence" *in toto*, and to maintain that all experiences are equally independent and objective, that only things, and not thoughts, exist at all? For Perry, the answer appears to be negative; this view, he observes, "is not part of realism." "Values," "interests," "higher complexes, such as history, society, life or reflective thought," all these *are* "dependent on consciousness." Independence, then, is not universally predicated of things experienced; all that is maintained is that "*in certain notable cases, at least*, things are none the less independent for being perceived." But this is an immense and fatal qualification of the relational theory. For if consciousness is *capable* of having content that depends upon it for existence, that is purely its own, one obviously can not argue from a general incapacity of consciousness to constitute its own content to the conclusion that the objects of perception are independent, etc. The nerve of the main positive argument for both realism and epistemological monism is thus cut. If consciousness is in some cases an external and in some cases a constitutive "relation," it becomes necessary to adduce specific empirical evidence to show that in each and every case of perception it is of the former sort. And no such evidence is offered. Strictly empirical evidence, indeed, it is manifestly impossible to offer; since things are always experienced in the consciousness-relation, experience, at least, can not testify to their independence of and externality to that relation. If, then, we take the external-relation theory in Perry's sense—as meaning merely that consciousness *may be* an external relation—we must admit the theory to be true. There are, doubtless, external relations; and it is conceivable that "being in consciousness" may sometimes be one of them. But from this "may-be" no proof of the neo-realistic theory of perception can be drawn; yet no other positive proof is given.

Others of the group, therefore, avoid

Perry's damaging concession. Pitkin, for example, declares that "the realist can not count his case won" until he has shown "the complete independence of all things thought of." He feels obliged, therefore, to hold that even hallucinatory objects, and errors of all sorts, are "no less independent of cognition than true propositions are." That secondary qualities, illusory presentations, and the like, can all be, without contradiction, conceived as objective and independent, Montague, Holt and Pitkin alike are concerned to show; and the only imaginable reason for their undertaking to justify this paradox is an acceptance of the view that consciousness is *in no case* constitutive of any perceived content, that it is always and absolutely a relation which does not create its terms nor modify their other relations.

But for this more rigorous construction of the relational theory, what evidence is offered? It, if established, would prove neo-realism's case, as I have admitted; but by what argument is this all-important premise itself to be established? Of general and positive arguments for it there are, so far as I can see, none in the book. Direct empirical evidence is, once more, unattainable, in the nature of the case, and is not attempted. What we are given is merely a series of attempts to show that the theory is not absurd, that the general and unqualified assertion that no perceived datum ever does or can depend upon its relation to a perceiver for its existence or any of its attributes or its other relations, is not the extravagance which it at first appears to be. Even if these attempts be regarded as successful, they could not, by a rigorous logician, be regarded as establishing the conclusion desired. There are many propositions which are not absurd which are also not true. The battle for the relational view of consciousness can hardly be won by purely defensive tactics. But are even those tactics successful? To this question we must now turn.

2. Science, I have said, as well as popular thought, is still, as a rule, accustomed to think of some of the content of experience as existing "merely subjectively." The whole distinction between appearance and reality—in the ordinary, empirical sense—which science has found so indispensable has usually taken the form of the supposition that certain data of perception,—*e. g.*, the secondary qualities of matter, illusions, dreams, hallucinations—can be explained away as having their being only in "minds" and by virtue of minds, as *being* only in so far as, and only in the sense that, somebody is conscious of them. This, then, is the way of thinking and of speaking which the new realism (in so far as it treats its relational theory of consciousness as a universal proposition) invites us to give up. It therefore proposes a radical revision of widely current preconceptions. The important question to raise concerning it, then, is this: Can we, while maintaining realism, *completely* dispense with the idea of "subjective appearance," of "mental representations" of objects, can we hold without self-contradiction that what things seem they also are, and that the entity present "in consciousness" whenever we perceive or think of an object is just the original, simon-pure object itself, untransformed, unduplicated and untransposed?

That their doctrine stands or falls with the answer to this question, the authors very frankly acknowledge. "The crucial problem," says Pitkin, "for the new realism is the problem of error (in all forms). And the acutest critics" of the doctrine "urge that its fatal flaw is the acceptance of the full 'objective' nature of illusions and errors and its simultaneous refusal to put illusory objects, with all their colors, shapes and behaviors, identically in the very space and time in which they immediately belong. If the charge is true it is deadly." To meeting this type of objection the papers of Montague, Holt and Pitkin are chiefly devoted.

Unfortunately space is lacking here for an adequate analysis of these highly ingenious and rather involved pieces of argumentation; that examination must be attempted elsewhere. For the present it must suffice to observe that these three writers are unable to agree upon any one "solution of the problem of error" in terms which shall be consistent with

their general doctrine. Each repudiates the solutions of the others; each, therefore, from the point of view of the others, has no logical right to be a new realist, since he fails (in their eyes) to meet satisfactorily an objection which admittedly must be met before the new realism can be regarded as tenable. So long as these spokesmen of a common cause, after prolonged conference and discussion *inter se*, are unable to convince one another, no one of them will feel it surprising that he fails to convince *his* readers. Nor is this the worst of the situation. In an appendix definite refutations are offered of all three solutions; Montague refutes Holt and Pitkin, and Pitkin refutes Montague. This does infinite credit to their candor and philosophical good faith; but it leaves their doctrine in a parlous state. For both appear to me to be perfectly good refutations; so that at the end of the volume the formal outcome of the triple effort to solve the problem of error and meet the opponent's argument from hallucinations is literally *nil*. $3-1-1-1=0$.

Thus far, then, I do not think it can be said that these vigorous innovators have demonstrated that consciousness does not exist save as an irrelevant relation between objects always and absolutely uncolored by its presence; or that the convenient supposition that some things in consciousness exist solely therein, as "subjective appearances," must be abandoned. But failing a proof of this, the new realism, as a whole, is lacking in logical substructure.

In the interest of a discussion of this main issue, I have been obliged to omit mention hitherto of two carefully reasoned papers which are less closely related to that issue: that of Marvin on "The Emancipation of Metaphysics from Epistemology" and that of Spaulding, "A Defense of Analysis." These both reward the reading irrespective of one's interest, or lack of it, in the new realism. Spaulding's paper contains an effective analysis of some of the confusions of Bergson and other anti-intellectualists.

Professor Fullerton's book also is a defense of "the new realism," but apparently not of the same new realism. We shall soon be obliged to distinguish the various claimants of the name by numerals. Just how Fullerton's view is logically related to that of the authors already discussed, it is a matter of some difficulty to determine. He sometimes seems plainly to reject the relational conception of consciousness and the resultant epistemological monism. "The world," we are told, "is phenomenon; it is in a sense a function of the creature perceiving the world. Each gazes upon his own world." There is "a whole series of phenomenal worlds differing more or less from one another. Only one of these is ours and is known by us directly" (pp. 106–107). There are apparently some things which "should be regarded as existing only in the mind" (p. 129), which are "internal and subjective" (p. 131). Yet we are also told that we are "as directly conscious of external things as we are of anything whatever," and that "we may with a clear conscience accept as external the things we actually perceive, with just the qualities and relations which we perceive them to have" (p. 149). Thus even the secondary qualities are "external" and in no sense subjective (Ch. X.). We do not perceive images of objects, but the objects themselves. Even so qualified a form of the representational theory of perception as Strong's "substitutionalism" is rejected (p. 158). Thus, so far as normal perception is concerned, Fullerton seems first to deny and then to adopt the theory of the immediacy or "immanence" of the real object in perception. The final criterion, however, of any writer's attitude towards the view that consciousness is an external relation lies in his explanation of the facts of error and hallucination. Is the hallucinatory object a function of the perceptual process or is it, too, "external" and independent thereof? Does the long-extinct star "really exist" at the moment when I belatedly perceive it? If not, does not the star actually perceived subsist at the moment in dependence upon the consciousness of that moment? Unfortunately, Fullerton, while he raises these questions, does not meet them in a way which unequivocally de-

fines his attitude to the relational theory. He observes (pp. 156–163) that our errors are largely mere omissions and not creations; that even illusions "deceive no well-informed person"; and that "were men sufficiently well-informed, and were such experiences sufficiently common, there would in no case be the shadow of an illusion," which seems to mean only that if there were no illusions there would be no illusions. The fact remains that illusions, hallucinations and dreams occur; and the question is whether (as some neo-realists hold) the content presented in these can be said to exist in real, objective space, at the time of its presence in consciousness, and whether there is any justification for, or meaning in, calling it "independent" of consciousness. To this question, with which the other new realists so laboriously deal, Fullerton, so far as I can see, gives no entirely plain answer; and it is for this reason that the relation of his realism to theirs remains, at the most significant point of all, obscure. I take it, however, that he does *not* view consciousness as an absolutely functionless relation, and that he would reject the paradox of the objectivity of the illusory.

Assuming this to be his meaning, Fullerton must be understood to regard some content of perception as purely mental, or subjective, and some as wholly objective and independent. The further question remains: Where, and by what criterion, shall we draw the line between the two? Patient and subtle as are Fullerton's reasonings upon this point, I do not find them altogether clear or convincing. His desire, evidently, is to make the realm of the subjective a very little one; hence his exclusion from it even of the secondary qualities, and his apparent reduction of it to the hallucinatory and imaginary merely. But his reasons for drawing the line where he does appear to me blurred through a failure to give and adhere to a single, clear definition of "external" and "objective." In a general way one gathers that (pp. 111–115) things and qualities are external, in the proper sense, when they do not involve a "relation to our sense-organs," when I "can account for them without referring to the relation of my body to them." But this throws little light upon the subject. How am I to know when data which are obviously mediated through my sense-organs involve no relation thereto? When (as in the case of color) specific variations in my sense-organs are uniformly accompanied by specific variations in the qualities which appear in consciousness, are not the latter, in accordance with the definition given, "internal" or mental? But in that case, what becomes of the proof of the externality of color-qualities? Does Fullerton, then, mean that anything is external which without contradiction can be *conceived* as existing without involving the idea of my body? If this is what is meant, one must still object that there are familiar arguments which seem to show that most of the perceived qualities which one object presents to different percipients *are* reciprocally contradictory, so long as the qualities are regarded as inhering independently in the object by itself, and not as functions of its diverse relations to those percipients. These points not being satisfactorily dealt with, Fullerton's realistic construction fails of complete definiteness of outline and consequently of cogency.

A noteworthy part of the book is the interpretation of Kant as the "first great modern realist" (Chaps. V.–VII.); this view is not new, but it has never, perhaps, been so forcibly presented. The most brilliant chapters in the volume are the critical ones. The passages on absolute idealism and on pragmatism are delightfully witty, yet eminently searching, examples of philosophic satire. The latter, I think, is less than just to some aspects of pragmatism; but the former (Chaps. XIII.–XV.) is a masterpiece in its kind.

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Handbuch der Entomologie. Herausgegeben von Professor Dr. CHR. SCHRÖDER. Jena, Gustav Fischer. 1913.

For the past twenty years Kolbe's "Einleitung" has been the best known German text-book on entomology. Now Dr. Schröder

(editor of the *Zeitschr. f. wissenschft. Insektenbiologie*) has undertaken to issue a more extensive work. It is significant of the increasing specialization in entomology that this new work is not the product of one author, but of eleven. It is divided into three parts: Volume I. is on the Anatomy, Embryology, Morphology, and Metamorphosis, and is prepared by Dr. C. Börner, Professor P. Deegener, Dr. J. Gross, and Dr. O. Prochnow. Volume II. will treat of the Habits, Distribution, Economic, and Experimental Entomology, and will be written by Dr. Schröder, Dr. K. Eckstein, Dr. O. Heineck, Dr. K. Holdhaus, Dr. L. Reh, and Dr. H. Rübsaamen. Volume III. will consider Paleoentomology, Phylogeny, and Systematics, and is to be prepared by Dr. A. Handlirsch. The portions now issued (three parts of Volume I.) are almost wholly by Dr. Deegener. Chapter I. is on the skin (including color, scales, skin-glands, scent-glands, wax-glands, etc.) with an appendix on the sound organs; Chapter II. treats the nervous system (especially the larger ganglia); Chapter III., the sense-organs, largely histological. In this chapter are various minor errors; the great family Capsidæ is not mentioned under Heteroptera as being without ocelli, the Panorpatæ are stated to have three ocelli, although on a previous page the genus *Boreus* is correctly stated to be without ocelli, and the various cases of ocelli in Coleoptera are unmentioned. The various sense-organs of unknown purpose (pseudocelli, abdominal organs of moths, post-antennal organs) are considered, as well as the supposed correlation or rather complemental development between the eyes and the antennæ. Chapter IV. considers the alimentary canal and its appendages (salivary glands, malpighian glands, anal glands) and is very complete, as Dr. Deegener is particularly interested in this matter. Chapter V. is on the respiratory organs, and is rather one-sided, most attention being given to respiration in aquatic insects and in parasites. Chapter VI. treats of the circulation, blood, heart, the specific heat of insects, fat-bodies, light-organs (rather briefly) and œnocytes. Chapter VII. relates to the endoskeleton and muscles. The muscular system of the imago of *Dystiscus* (as given by Bauer) is taken as typical, with but little comparison to other insects or larvæ. Only a brief summary is given of the endoskeleton, and brief treatment of muscular contraction, attachments of muscles, and muscular power of insects.

The most useful feature of the work is the long bibliographies at the end of each chapter. Although not by any means complete (American references often lacking) these lists furnish references that are difficult to secure but essential to any one studying these subjects. In fact, so useful is this new "Handbuch" that we hope a group of our entomologists will plan an American work on the same general lines.

Nathan Banks

TRIALS AND TROPISMS

I

Some years ago[1] I attempted an analysis of the facts grouped under the familiar but apparently confusing term "tropism theory." In the light of my experience I found myself seriously questioning the validity of a view that had just been published by Jennings in his well-known book, "The Behavior of the Lower Organisms." The issue was essentially this: whether tropisms are developed through selection from overproduced movements by means of the method of trial, or whether they are primary responses in the same sense that these overproduced movements are, and not, therefore, products of a process of selection as suggested.

Jennings soon found opportunity to reply to my objections as well as to those of other critics, notably Loeb and Parker. His reply, however, does not appear to have convinced them, for they have both taken issue since with his conception of the nature of tropic reactions. And though, up to the present, I have not thought it either necessary or desirable to add my own misgivings to a rapidly

[1] "The Method of Trial and the Tropism Hypothesis," Science, N. S., XXVI., pp. 313–23, September 6, 1907.

growing controversy, I too have failed to be convinced. Controversies fatten on misunderstandings. There is evidence that this one has been no exception to the rule. Some of it may be found in a recent book by Mast[8] and in a review and reply[9] that have since appeared. Accordingly, silence might seem to be the better part. Nevertheless, I am tempted to brave the possibility of further difficulty by accepting what seems to be a reasonable chance of focusing attention more sharply than before on the issue raised in my former paper.

It will be my endeavor, then, to show why the view that tropic reactions are developed through selection of overproduced or trial movements is unsatisfactory. And I shall attempt to do this by calling attention to certain relations between the structure and behavior of non-symmetrical and bilaterally symmetrical organisms that have heretofore met with much scantier consideration than, in my opinion, they deserve. Let me refer first of all to the behavior of the non-symmetrical flagellate *Euglena.*

II

Euglena, as is well known, is a non-symmetrical unicellular organism, with a single non-symmetrically placed photoreceptive region near the gullet, and swims in a spiral path by means of a flagellum, or, in the absence of the latter, assumes a crawling habit that is accompanied by a side-to-side oscillation suggesting the spiral swimming of the flagellated form.

I have been very much impressed by Mast's account of the orientation of the crawling *Euglena* to light. It appears that the organism, crawling in a path perpendicular to a beam of light, on entering the beam executes a turning movement toward the source of light; that this turning movement is accomplished by a series of sharp reactions, defined by a bending of the body away from the source of light; that each reaction follows an abrupt change in intensity of light falling on the photoreceptive region; and that these abrupt changes are connected with the oscillation of the organism from side to side, leading to an intermittent presentation of the photoreceptor to the light in a position effective for stimulation.

Few will deny that constant stimulation plays no obvious rôle here. But many, I am sure, will not fail to be impressed with certain elements of similarity in structure and behavior between *Euglena* and various bilaterally symmetrical organisms with one of a symmetrical pair of eyes blinded. And just here appears a point that has not been always clearly apprehended by the author of "Light and the Behavior of Organisms." Somehow Mast has obtained from my former paper the impression that I evidently consider "that orientation [in *Euglena*] is due to the local effect of unequal stimulation of symmetrically situated points on the body"—and yet do not "explain where the symmetrically located points which are subject to local stimulation are situated in *Euglena.*" I have looked carefully over my paper since this statement came to my notice, but have not been able to find any attempt to explain the orientation of *Euglena* on any such basis. That was perhaps a result to be expected, as I had not been conscious of an attempt so to explain the orientation of *Euglena* or any other non-symmetrical organism. Of the symmetrical points to which "it is evident" I refer, I frankly confess my ignorance. Nor do I feel any more hopeful than Mast himself of a successful issue to the most exhaustive search for them. Our reasons for this attitude of mind, however, do not coincide. For mine, the reader is referred to that suggestive resemblance between the structure and behavior of non-symmetrical organisms and symmetrical organisms non-symmetrically stimulated to which I would again call attention.

III

Let us imagine *Euglena* crawling horizontally along a definite axis of locomotion, directly toward a source of light. At successive

[8] "Light and the Behavior of Organisms," New York, 1911.

[9] Parker, *Jour. An. Beh.*, Vol. I., 1911, p. 461; and Mast, *ibid.*, II., p. 209.

moments it comes to lie in different positions, in all of which the single photoreceptor is at the same distance from the axis, and in some of which it occupies positions that—if the forward movement be for the moment disregarded—are symmetrically placed with reference to a plane passing through the axis of locomotion and perpendicular to the substratum. Let us now compare two such symmetrical images of *Euglena* with a bilaterally symmetrical animal, with paired eyes, moving directly toward a source of light. In *Euglena* the single photoreceptor is now on the left, now on the right of the plane of symmetry. In the other organisms, the two photoreceptors are permanently fixed, and one on each side of that plane.

Now *Euglena* swerves toward the light only when it is in such a position that the photoreceptor when on one side of the plane of symmetry receives light at an angle differing from that at which it receives light from the same source when occupying a symmetrical position on the other side of the plane. Just so, according to all varieties of the tropism theory with which I am acquainted, various bilateral organisms swerve toward the light when their eyes, symmetrically placed on either side of the median plane of the body, receive light from a single source at different angles. Expressed in another way, this means that the eyes under such conditions are subjected to different effective light intensities. The very mechanism, then, which has long been held by advocates of the tropism theory to account for the definite, errorless turning movements of bilateral heliotropic organisms toward or away from light, is the mechanism that Mast has shown to be accountable for the heliotropic orientation of the non-symmetrical *Euglena*. If this be the case, it seems evident that, whether or not the separate reactions of *Euglena* whenever its photoreceptor is effectively presented to the light are to be regarded as overproduced movements that may resemble trials, the definitely directive reactions of bilateral animals to light have not been developed by any process of selection based on such movements.

IV

It remains to consider the possibilities of such a mechanism for producing the delicately accurate heliotropic adjustments of some organisms; as well as the relation between pronounced shock reactions with no obvious relation to the direction of locomotion, and the definite errorless turning movements ordinarily referred to as tropic reactions.

Mast[4] says of the orientation of *Euglena* in light from two sources:

> When the light from the two glowers was equal and the *Euglenæ* positive, they moved in a general way toward a point midway between the glowers. But when it was unequal, they moved toward a point nearer the source from which the more intense light came. . . . This experiment is particularly striking if the glower on the track is gradually moved from a position in which the light intensity from it is much lower than that from the stationary glower to a position in which it is much higher. Under such conditions one can clearly see these organisms, especially the free swimming forms, gradually change their direction of motion through an angle of nearly 90°.

I gather from this description that changes in intensity are followed by reactions that vary with the degree of change. If this be true it may well account for the very slight variations which bilaterally symmetrical heliotropic organisms make from a straight course toward a source of light, and the precision with which such variations are corrected.

Further evidence of this sort is obtained from Fig. 13, p. 96, where, if the reactions are to be considered accurate in detail as drawn, it is seen that the orienting contractions of *Euglena* vary in magnitude as the path of the organism inclines more and more toward the source of light.

Similarly, Jennings[5] describes the avoiding reaction of the free swimming *Euglena* in the following terms:

> The *Euglenæ* are swimming about at random in a diffuse light, when a stronger light is allowed to fall upon them from one side. Thereupon the for-

[4] "Light and the Behavior of the Lower Organisms," p. 86.

[5] "Behavior of the Lower Organisms," p. 138.

ward movement becomes slower and the *Euglenæ* begin to swerve farther than usual toward the dorsal side. Thus the spiral path becomes wider and the anterior end swings about in a larger circle and is pointed successively in many different directions. In some part of its swinging in a circle the anterior end of course becomes directed more nearly toward the light; thereupon the amount of swinging decreases, so that the *Euglena* tends to retain a certain position so reached. In other parts of the swinging in a circle the anterior end becomes less exposed to the light; thereupon the swaying increases, so that the organism does not retain this position but swings to another. The result is that in its spiral course it successively swerves strongly toward the source of light, then slightly away from it, until by a continuation of this process the anterior end is directed toward the light. In this position it swims forward.

Figs. 91 and 92, p. 135, show variations in the severity of the reaction, the second figure representing but a very slight widening of the narrow spiral in which the organism has been swimming. Fig. 93, p. 139, represents the path of a *Euglena* executing a turn of 180° by a series of similar slight widenings of the spiral.

From such evidence it would seem that the motor reflexes of *Euglena* appear in varying degrees that shade more or less gradually into each other as the strength of stimulation varies. This admirably meets the requirements of a "tropism theory" that is expected to account for the gradual but definite and errorless turning movements executed by so many bilaterally symmetrical organisms in orienting themselves with respect to a source of light.

These considerations inclined me to the view that in bilaterally symmetrical organisms the shock reactions that have no obvious connection with orientation to a stimulus and are produced by *sudden changes in intensity* of light may occupy one end of a series at the other end of which are the very small reactions by means of which the tropic turning movement is achieved. In that case the difference in effect on orientation of these extreme cases would not indicate any fundamental difference in mechanisms governing them, but rather a pronounced difference in the magnitude of the responses to stimuli of different intensities.

Recently, however, my attention has been called to new evidence, shortly to be published by my friend, Dr. F. W. Bancroft, that in *Euglena* the mechanisms of the shock reaction and the tropic reaction are distinct. How general this observation may prove to be is not now certain. But in any case, the shock reaction can hardly be said to occupy the position of a prototype from which trialless heliotropic turning movements have been derived by any process of selection.

HARRY BEAL TORREY

REED COLLEGE,
PORTLAND, OREGON,
January 9, 1913

AN AID TO STUDENTS

THE Academy of Natural Sciences of Philadelphia has published, as part of the aftermath of the brilliant centenary celebration of last year, an index to its publications from the first volume of the *Journal* issued in 1817 to the conclusion of the sixty-second volume of the *Proceedings* completed in 1911, making a total of eighty-three volumes. The portly index comprises 1,433 octavo pages and is divided into two sections. The first contains the titles of all the contributions to the series, arranged alphabetically under the names of the authors, and ranges from brief paragraph reports of the communications made verbally before the meetings of the academy to the classic quarto volume by Joseph Leidy on the extinct mammalian fauna of Dakota and Nebraska, and the beautiful monographs on the burial mounds of the south by Clarence B. Moore.

The second section is composed of an alphabetical arrangement, from *aalensis* to *Zythia*, of the names of every species, genus, and family described or referred to in the several volumes. It is estimated that there are about 124,600 such entries in the list and some idea of the labor involved in its preparation and arrangement may be had from the fact that the original entries under the letter P numbered 19,500, under S 16,650 and under T 10,800.

These were, of course, condensed in the arrangement, all the page references to a given name being placed under a single entry so that the printed result is much curtailed.

During the first five years of the academy's life it maintained a sort of chrysalis existence without much communication with the outside world. Of the six men who attended the initial meeting but one, the Dutchman Gerard Troost, later elected the first president, had any scientific training. At the next meeting Thomas Say was "adopted" by the others as one of the founders and he has since been regarded as one of the seven to whom the academy owes its existence. The communications to the meetings were at first confined almost solely to selections from Rees's Encyclopedia and certain text-books of science, but original observations soon became more frequent and by 1817 a sufficient amount of such material was in possession of the society to warrant the belief that an avenue of publication would be desirable. Through the interest and zeal of William Maclure, a Scotch philanthropist, the first number of the *Journal* was placed before the meeting held May 20, 1817. The volume contained contributions from Chas. A. Lesueur, Geo. Ord, Thomas Say, Thomas Nuttall, and William Maclure. Its interest and value were much enhanced by the beautiful engravings by Lesueur. It was at the time the only avenue of communication with the scientific world possessed by the working naturalists of America.

This series staggered on with intervals of quiescence until 1842, when it was decided that the *Proceedings,* which had been begun the previous year for the purpose of giving prompter publicity to the current business of the academy, supplied all that could be secured by an octavo publication.

To provide for papers requiring more elaborate illustrations than could be supplied in the octavo form, a quarto journal was started in 1847 and has been continued to the present time, the superb fifteenth volume having been published last December as the chief memento of the celebration held in March. Incidentally it may be mentioned that the prompt issue of that volume, within nine months of the event it records, has been regarded all over the world as a record-breaking achievement. The illustrations to the quarto series were from the first of a high order of artistic merit. Special mention may be made of the colored illustrations of Cassin's birds, supplied by the liberality of Thomas B. Wilson; the really beautiful lithographs by Ibbotson of Isaac Lea's Melanians and Unios; and more recently the superb chromoplates of prehistoric pottery furnished by Mr. Clarence B. Moore in illustration of his monographs.

Access to the scientific contents of the eighty-three volumes, constituting one of the most important agencies in the advancement of science, will be greatly facilitated by the issue of the index which will undoubtedly be highly valued by students.

A few pages are devoted to a record of the time of publication of the several parts and volumes. The minutes, correspondence, and accessions lists of the academy were consulted to determine as many such dates as possible, and it is to be regretted that the result is not complete, the requisite data not being at hand, after the most careful search, to make it so. As far as the record goes, however, it will establish dates of publication of many researches of the first importance and help to determine many questions of priority, a matter to which the working naturalist is apt to attach much more importance than do those who value results without caring greatly as to who attains them.

EDW. J. NOLAN

SPECIAL ARTICLES

FACTORS INFLUENCING THE SURVIVAL OF BACTERIA AT TEMPERATURES IN THE VICINITY OF THE FREEZING POINT OF WATER[1]

IT has been held by some bacteriologists that, while temperatures about the freezing point of water are less destructive of bacterial life than those about the boiling point, low temperatures are not only unfavorable to the growth and multiplication of bacteria, but

[1] Preliminary communication.

also to their prolonged existence. Prudden's experiments (1887) with water suspensions of a staphylococcus, in tubes greased to prevent crystallization at the temperatures employed (15–25° F.), led him to believe that at the same temperature the destruction of bacteria, due to cold, was greater when the water did not freeze, than when it did. Park, however, made similar experiments (1900) with *B. typhosus* and found that at the same temperature the reduction was 30 per cent. less in water remaining liquid for three days than where the water was frozen for the same length of time. Park further cites an experiment upon the freezing of typhoid bacilli in which 50 per cent. to 70 per cent. are killed "at the time," not more than 10 per cent. surviving after one week and 1 per cent. after four weeks, while Sedgwick and Winslow, after a careful review of the literature and many experiments, came to the conclusion that there is "during the first half hour of freezing a heavy reduction . . . amounting to perhaps 50 per cent. After this brief period of sudden but uncertain 'reduction' the destruction of the germs proceeds pretty regularly as a function of the time." Prescott and Winslow in their "Water Bacteriology" remark (p. 17) that "Temperature has a direct relation to bacterial life, and the number of parasitic bacteria at least may be quickly lessened by the action of cold." These conclusions are supported by the fact that ice, and especially old ice, even when formed from polluted sources, is very low in bacterial life.

On the other hand, it has gradually become known that various frozen foods, such as ice cream, frozen meat and frozen milk, often contain very large numbers of living bacteria, and this, too, even when kept for a long time, so that a serious contradiction seems here to exist between theory and fact. To this contradiction my attention was first drawn some two years ago during bacteriological studies of frozen eggs, and especially by the fact that such eggs, even after an exposure of many months to a temperature of 0° F., still contained millions of living bacteria. Obviously it was no longer possible to hold that either mere cold or time is in and of itself necessarily destructive of bacterial life; and in the hope of bringing theory more clearly into harmony with experience I have within the last year made numerous experiments calculated to throw further light upon the general behavior of bacteria at temperatures about the freezing point of water.

Thus far I have worked almost exclusively with a single species, *B. coli*, which, as is well known, thrives at various moderate temperatures and especially at the blood heat. I have employed chiefly a 24-hour agar growth suspended in water, in physiological salt solution, in various dilutions of fat-free milk, in various mixtures of pure glycerine and water, and in solutions of cane sugar and of commercial glucose. In some cases freezing was done directly in test tubes; in other cases in an ice cream freezer with the formation of an ice "mush" or magma. By the courtesy of the Quincy Market Cold Storage and Warehouse Company of Boston I have been able to hold the suspensions thus frozen at temperatures as low as zero F. for periods of from four to eight months. The experiments are still in progress and some of them may be extended over a term of years.

The following is a brief summary of results:

I. When *B. coli* are frozen in Boston tap water (in test tubes) as solid ice, and held at — 20° C., only a fraction of one per cent. of the original number remain alive at the end of five days. Storage of a few weeks results in complete destruction of the bacteria. These results confirm those of Sedgwick and Winslow.

II. When *B. coli* are frozen in Boston tap water not solidly, but as a water ice or sherbet is frozen, and held in this condition at — 20° C., a large percentage remain alive for many months.

III. When *B. coli* are frozen in milk, pure and diluted to various degrees with water, the death rate of *B. coli* increases with the dilution, the largest numbers surviving in the un-

diluted milk and the fewest in that containing the most water.

IV. When suspended in aqueous mixtures containing from 5 per cent. to 42 per cent. of chemically pure glycerin and held at — 20° C., a very large percentage of *B. coli* remain alive for at least six months.

V. At + 37° C., *B. coli* in water or in 5 per cent. to 20 per cent. glycerin[3] die rapidly, few if any remaining alive at the end of 72 hours. The death rate diminishes as the holding temperature is lowered, though it is still marked even just above 0° C.; but at a temperature slightly lower a sudden change appears, the death rate at and below that point being but little, if any, greater than at — 20° C.

VI. By covering a 24-hour growth on agar with a sterile 10 per cent. cane sugar solution, and holding at — 10° C., stock cultures of *B. subtilis*, *B. aurococcus*, *B. megaterium*, *B. fluorescens*, *B. proteus* and *Sarcina aurantiacus* have been kept in a vigorous condition (without transferring) for eight months.

From these results the following conclusions may be drawn:

Low temperatures alone do not destroy bacteria. On the contrary, they appear to favor bacterial longevity doubtless by diminishing destructive metabolism. Frozen food materials, such as ice cream, milk and egg substance, favor the existence of bacteria at low temperatures, not because they are foods, but apparently because they furnish physical conditions somehow protective of the bacteria.

It seems likely that water-bearing food materials as well as sugar solutions, glycerin solutions, etc., freeze in such a way that most of the bacteria present are extruded from the water crystals with other non-aqueous matters (including air) and lie in or among these matters without being crushed or otherwise injured; while in more purely watery suspensions, and, above all, in water itself in which the whole mass becomes solidly crystalline, they have no similar refuge but are perhaps caught and ultimately mechanically destroyed between the growing crystals. This theory would explain the absence of live bacteria in clear ice, their comparative abundance in "snow" ice and "bubbly" ice, and also the fact that the more watery food materials when frozen contain the fewest, and the least watery the most, living bacteria.

The comparatively rapid death of bacteria in non-nutrient materials at higher temperatures and their slower dying at lower temperatures agrees well with the theory of simple starvation or destructive metabolism. At the higher temperatures they perish quickly because they burn themselves out quickly; at the lower, more slowly, because they consume themselves more slowly. At temperatures where metabolism ceases altogether they continue to exist in a state of suspended vitality similar to that exhibited by many other and higher plants which in the far north are subjected without apparent injury for long periods to temperatures much below the freezing point of water.

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[3] Glycerine mixtures much exceeding 20 per cent., at temperatures above the freezing point of water, act as mild antiseptics. Under 20 per cent. this is not the case, the death of the bacteria apparently resulting from lack of food, as it does not occur when a small amount of peptone is present.

HEMOPHORIC FUNCTION OF THE THORACIC DUCT IN THE CHICK

IN a recent investigation of the development of the thoracic duct in the common fowl, the writer studied also certain aggregations of mesodermal cells correlated with the developing duct, and considered by Sala,[1] more than ten years ago, as "cords" of mesenchymal cells out of which were "hollowed" the rudiments of the duct.

The writer believes, and in the near future will publish evidence to substantiate the belief, that these aggregations of mesodermal (mesenchymal) cells comprise developing blood cells which are differentiated *in situ* out of the indifferent mesenchymal syncytium, that these blood cells then gain access to the lymph

[1] Sala, *Richerche fatta nel Lab. di Anat, Norm. della R. Univ. di Roma*, Vol. 7, 1900.

channels making up the developing thoracic duct, and that finally the hemal cellular elements in question reach the blood stream *via* the thoracic duct and jugular lymph sac. Considering the vast number of blood cells, especially erythrocytes, arising in this region and the probability that they are conveyed to the general circulation by the thoracic duct, this duct assumes, therefore, an additional phase of importance in the chick in that it performs a hemophoric, or blood-carrying, function.

The view that the thoracic duct may arise as detached portions of veins is in the case of the chick quite untenable, since the tissue in which the lymph spaces and channels arise remains notably non-vascular up to the time the first lymphatics appear. The writer believes he has sufficient evidence, soon to be published, to show that the lymphatics arise as isolated lacunæ directly from mesenchymal intercellular spaces, are not in any sense derived from veins, and subsequently coalesce to form the continuous channels of the thoracic duct.

The point recently made by other investigators,[2] namely, that the superficial lymph plexus in the region of the posterior lymph heart in the chick contains stagnant blood which has backed up into it from the veins, is invalid in the case of the thoracic and its blood content because there are no veins in this region from which "backing up" could occur.

ADAM M. MILLER

[2] Clark, E. L., *Anat. Record*, Vol. 6, No. 6, 1912; Clark, E. R., *Anat. Record*, Vol. 6, No. 6, 1912.

A POSSIBLE MEANS OF IDENTIFYING THE SEX OF (+) AND (—) RACES IN THE MUCORS

It has been shown by the writer (1) that the majority of the forms among the mucors are diœcious, with the sexes separated in male and female races which are capable of being propagated apparently to an indefinite number of vegetative generations by means of nonsexual spores formed in sporangia. In all the diœcious species carefully investigated the opposite gametes, which are produced and unite to form zygospores when the two sexual races of a given form are grown together, do not appear to differ morphologically. Lacking a definite criterion which an inequality of the gametes would have afforded, the writer has provisionally designated the opposite sexes in these forms by the signs (+) and (—) on account of a generally greater vegetative[1] luxuriance of one sex over the other. That in reality the two sexes are represented in the (+) and (—) groups is shown by the sexual reaction which may occur not only when the (+) and (—) races of the same species are grown together and perfect zygospores are produced, but also by the sexual reaction which may occur when (+) and (—) races belonging to different species are grown together. This reaction between the opposite races of different species has been called imperfect hybridization since it does not lead to the formation of perfect hybrid zygospores, but usually stops short with the formation of progamates, though occasionally gametes are produced which, however, never unite.

A sexual race of a diœcious species if grown between the (+) and (—) races of another test species used as a standard, will show a line of sexual reactions on one side only. Some of the hermaphroditic species, on the other hand, when similarly grown, show a response to both (+) and (—) test races and produce therefore 2 lines of sexual reactions.

Some few species in the hermaphroditic group are distinctly heterogamic with a constant difference in size between the conjugating gametes. Figs. 1–6 in the accompanying diagram will illustrate the process of conjugation in such forms. It seems reasonable to consider the larger gamete female and the smaller male. Upon this basis, if a sexual reaction could be established between these unequal gametes and the (+) and (—) races, the race reacting with the larger female gamete must be considered male, while the race reacting with the smaller male gamete must be considered female.

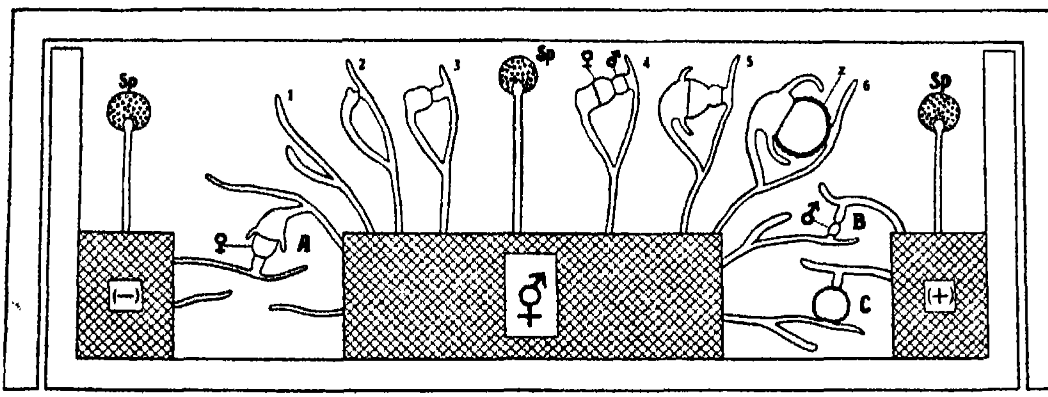
[1] "Zygospore Formation a Sexual Process," SCIENCE, N. S., 19: 864–866, 1904; "Sexual Reproduction in the Mucorineæ," *Proc. Am. Acad.*, 40: 205–319, pls. 1–4, 1904.

The difficulties in technique involved in following the sexual reactions in a thicket of filaments have been overcome by growing the heterogamic hermaphrodite (⚥) in a Petri dish between the (+) and (—) test strains and cutting channels in the nutrient agar between the different growths. If the Petri dish be then inverted, the growth of the reacting filaments may be followed in mid air in the channels.

Only a single heterogamic species has been found which will give reactions with both (+) and (—) races and only a single diœcious species which will react with both male and female gametes of this heterogamic hermaphrodite. These have accordingly been used in making the tests shown in the accompanying diagram.

In the left hand channel at *A* in the diagram, a filament from the (—) race is shown giving a sexual reaction with the larger ♀ gamete of the hermaphrodite, while in the right-hand channel at *B* a filament of the (+) race is figured, showing a sexual reaction with the smaller ♂ gamete of the hermaphrodite. The male gamete, which has been cut off from a filament of the hermaphrodite at the stimulus of contact with a (+) hypha, frequently surrounds itself with a thick wall and assumes the appearance of a resting azygospore, as is shown at *C*.

Of three other heterogamic hermaphrodites investigated, two show a sexual reaction with the (+) race only and one with the (—) race only. It is difficult to interpret the sexual reaction when shown with only one of the two sexual races.



SEXUAL REACTION BETWEEN A HERMAPHRODITIC MUCOR AND (+) AND (—) RACES OF A DIŒCIOUS SPECIES

Diagrammatic representation of a Petri dish culture showing a heterogamic hermaphroditic mucor (⚥) in the center separated by channels on either side from the (+) and (—) races, respectively, of a diœcious species.

Sp., Sporangia containing spores by means of which the plant may be reproduced nonsexually.
1–6, stages in development of a hermaphroditic zygospore from unequal ♂ and ♀ gametes.
A, sexual reaction between a (—) filament and ♀ gamete.
B, sexual reaction between a (+) filament and ♂ gamete.
C, a ♂ azygospore formed at stimulus of contact with a (+) filament.

Judging from the behavior of the forms figured in the diagram one would seem justified in considering the vegetatively more vigorous (+) race as female and the less vigorous (—) race as male.

The details upon which the conclusions in the present article are based are being published in another journal. The article itself is a summary of a paper presented before the Botanical Society of America, January 2, 1913.

A. F. BLAKESLEE

THE EFFECT OF MOLTING ON RHEOTAXIS IN ISOPODS

IN an earlier paper[1] I showed that the strength of a current in which stream isopods can maintain themselves is determined by the period of weakened responses during the breeding season. More recent studies have shown that the shorter but more frequently recurring molting period is also of importance in this respect.

The molt in the isopod, *Asellus communis* Say, usually occurs at intervals of from 13 to 25 days, although over 70 days may elapse between molts. Normally the covering breaks between the fourth and fifth thoracic segments. Either the anterior or posterior part may be shed first. Both may be molted the same night or as long as four days may intervene between the molting of the two halves. At times parts or all of the covering may be molted, segment by segment, or even parts of a segment may break off; as long as nine days has been observed to be spent in molting the abdomen alone.

The influence of this period on the rheotactic reaction is typically shown by the following account of the responses of an isopod during one molting period. The isopod under observation was a male, 12 mm. long, which averaged normally 86 per cent. positive rheotactic reactions. The molt began just after a test of 11 trials which averaged 35 per cent. positive, 35 per cent. negative and 30 per cent. indefinite. During each minute's reaction the isopod moved an average distance of 40 centimeters.

The covering broke between the fourth and fifth thoracic segments and the forward part was worked off over the head by a series of undulating motions of the body and by movements of all the legs. It took 70 seconds to complete the process. One of the antennæ that had been dragging before the molt occurred was dropped off with the exuvia. Immediately after the molt the forelegs were smaller than usual.

[1] Allee, W. C., 1912, "An Experimental Analysis of the Relation between Physiological States and Rheotaxis in Isopoda," *Jour. Exp. Zool.*, Vol. 13, pp. 269–344.

During the process the isopod stayed in one place and disregarded all currents. A current set up immediately after the molt was completed was also disregarded. After about two minutes in the same place the isopod moved across the pan and stopped in an angle 17 cm. away. It rested there quietly for seventeen minutes, when it was again tested for rheotactic reaction. No movement occurred. At thirty minutes after molting 10 trials showed 30 per cent. positive, 60 per cent. indefinite and 10 per cent. no reaction at all. The average reaction distance per minute was 38 cm. At this time the isopod was more sensitive to touch stimuli than usual. In the response just given it twice ran into another isopod with its antennæ and jumped back over a centimeter each time, although normally there would have been almost no negative reaction.

Three hours after molting, 70 per cent. of the reactions were positive, and two hours later 90 per cent. were positive and the reaction distance was 47 cm. This last trial was characterized by the steady movements and rapid, definite orienting that mark the normal response of stream isopods.

In this case the molt of the posterior part occurred two days later, after nine P.M. At nine the response was: 40 per cent. positive, 40 per cent. negative and 20 per cent. indefinite. The next morning 80 per cent. of the responses were positive and the other 20 per cent. were negative. The reaction distance was only slightly greater in the morning readings. On the morning after the next molt 31 days later, this isopod would start positive and turn negative as though the current pressure against the more sensitive covering was painful.

An isopod stands higher from the bottom when nearing molting time, which is probably due to the increasing stiffness of its legs. At this time the posterior legs appear harder to move and may become tangled, thus throwing the isopod as it tries to crawl. Immediately after the molt it is more easily swept off its

feet than during other parts of the molting cycle.

The more gradual molts may also affect the rheotactic reaction. A cut of 20 per cent. in the positive response has been observed when one segment was molted. Regulation from depressed to normal positiveness occurs more rapidly after a molt than at any other time.

The detailed account just given shows that the effect of the molting period lasted for about five hours after the actual ecdysis took place. If the period extended as long beforehand it would make the time during which the rheotactic response is affected by the molting process extend over a period of ten hours. Since both the rheotactic and thigmotactic responses are weakened, this must be a critical time in the life of the stream isopod.

W. C. ALLEE

A NEVADA RECORD FOR THE CANADA OTTER. LUTRA CANADENSIS (SCHREBER)

No otter has apparently been known from Nevada, although *Lutra canadensis* is known to occur in Idaho, and the type specimen of *L. canadensis sonora* (Rhoads) was taken at Montezuma Well, Yavapai County, Arizona. The Walker-Newcomb Expedition of the University of Michigan, in the summer of 1912, found a species common on the Humboldt River in the vicinity of Elko and Carlin, in the northeastern part of the state, and from a trapper a specimen was secured for the Museum of Zoology (Cat. No. 44,419).

The specimen obtained, a large adult male, is evidently to be referred to *L. canadensis*, as at present defined. The coloration is not as pale as described for *L. c. sonora*, being dark liver-brown above and paler below, the cheeks, lips, chin and throat whitish; and the postorbital processes are not attenuated, as in *L. c. sonora*, but short and stout, as in typical *L. canadensis*.

ALEXANDER G. RUTHVEN,
FREDERICK M. GAIGE

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

THE eighty-seventh regular meeting of the Botanical Society of Washington was held at the Hotel Cochran, February 25, 1913. This was the regular annual opening meeting of the society. Fifty members and forty-two guests were present.

The retiring president, Mr. W. A. Orton, delivered an address entitled "Environmental Influences in the Pathology of *Solanum tuberosum*." This paper was published in the *Journal of the Washington Academy of Sciences* (Vol. 3, p. 180, April 4, 1913).

The eighty-eighth regular meeting was held in Assembly Hall, Cosmos Club, Tuesday evening, April 1, 1913.

Mr. James T. Jardine was elected to membership.

The following papers were presented:

Notes on Diseases of Trees caused by Mistletoes: DR. G. G. HEDGCOCK.

Mistletoes are found only on conifers in northern and northeastern United States; only on angiosperms in southeastern and southern portions; and on both in western and southwestern regions, where they are the most widely disseminated.

The rate of spread of mistletoes is without doubt very slow. Near Frazer, Colorado, on an old burn in the forest, the rate of spread of *Razoumofskya americana* (Nutt.) Kuntze on the lodge pole pines (*Pinus contorta* Lond.) is estimated to be from 6 to 12 feet per annum, where mechanical expulsion of the seeds aided by winds are the controlling factors. Sporadic infections at much greater distances are caused possibly by birds or animals.

Light is the most important factor in determining the spread of mistletoes of species of both *Razoumofskya* and *Phoradendron*. Trees in the open, and in more exposed conditions, whether on ridges or edges of canyons or on level areas are most subject to attacks by mistletoes of both genera on account of the abundance of light. Trees in dense forests are not subject to attack. Mistletoes are stunted by dense shade, and bear but few, if any seeds, and can not well maintain themselves under conditions where the light is deficient.

One of the immediate effects of the presence of the sinkers of these parasites in the tissues of host trees and shrubs is a tendency to hypertrophy in the immediate region of penetration. In case of species of *Phoradendron*, unless the mistletoe plant is broken off there is little or no tendency for its sinkers to spread laterally in the tissues of the host, and when broken off, the rate of spread is slow, and no witches brooms are formed. In case of species of *Razoumofskya*, witches brooms are commonly produced. The lateral sinkers in such cases spread in the soft tissues of the host, keeping

pace with each year's growth, and sending forth new aerial shoots, from time to time. The stimulus of the presence of this ramifying network of the sinkers of the parasite causes an increase in the number of buds and twigs produced by the limb of the host attached and results in the formation of a more or less dense witches broom. The ability of the mistletoe to grow out to the extremities of the limbs enables it to send out shoots in the best illuminated portion of the broom, and bear seeds under the most favorable conditions of light.

All species of mistletoe are considered injurious in their final effect upon their host trees and shrubs. The leafy *Phoradendrons* are no doubt less injurious, owing to their increased chlorophyll-bearing surface and consequent greater ability to manufacture hydrocarbons. The leafless species of *Phoradendron* are more injurious than leafy ones. Species of *Razoumofskya*, owing to a very greatly reduced chlorophyll-bearing surface, are the most injurious of all. All species stunt the growth of the hosts. Owing to the slow spread of species of mistletoe in the forest, if all diseased trees are cut down on areas where timber sales are conducted, it will be possible to greatly lessen, if not entirely shut out these parasites from our future forests.

Notes on the Botany of Trinidad: Professor A. S. Hitchcock.

Mr. Hitchcock remained on the island of Trinidad from November 25 until December 31, except a few days spent on Tobago. On Trinidad there were collected 350 numbers of grasses, representing about 175 species. Grisebach (Fl. Brit. W. Ind.) describes 87 species from the island and Hart (Herb. List, Bot. Dept. Trinidad) lists 112 species. Several species known to grow in Trinidad were not obtained by Mr. Hitchcock, but many species were added to the known flora. Among the more interesting regions of the island were the Pitch Lake, where several species of grasses were found that were observed nowhere else, including *Panicum chloroticum* growing only in the water-holding depressions of the pitch; Aripo and Piarco Savannas, isolated low flat grassy openings in the valley of the Caroni River, where were found a probably new species of *Raddia* and *Paspalum serpentinum* Hochst. not found since the original collection by Keppler in Surinam nearly a century ago, and two new species of *Panicum;* and St. Joseph Savanna on the mountain side near the ancient capital of the island, St. Joseph. This savanna is of especial interest because the mountain sides are generally covered with forest except where cleared for cultivation. This savanna has occupied its present position since an indefinitely early period, as shown by the flora. The dominant grass is *Trachypogon plumosus*, a species which has not been reported from Trinidad. This species together with others of the association are the common constituents of the savannas found on the Pacific slope of Panama and Central America. In this savanna was found an undescribed species of *Axonopus*, a beautiful golden annual, allied to *A. aureus*. At Tabaquite in the center of the island in the original forest or "High woods" was found another undescribed species of *Raddia* and the rare *Pharus parvifolius* Nash. Several other apparently undescribed species were found on various parts of the island. Most of the species, whose types were from Trinidad, were recollected at their type localities. The results of the expedition to Trinidad and to Jamaica, visited earlier on the same trip, were very satisfactory and will supplement the large West Indian collections previously incorporated in the National Herbarium.

C. L. Shear,
Corresponding Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

The 468th regular and 34th annual meeting of the Anthropological Society of Washington was held in room 43 of the new building of the National Museum at 4:30 P.M., April 15, 1913, the president, Mr. Stetson, in the chair.

The minutes of the last preceding annual meeting were read and approved.

Obituary notices were presented as follows: Miss Alice Fletcher for Miss Sarah A. Scull; Mr. F. W. Hodge for Mr. W J McGee; Dr. Lamb for Dr. Robert Fletcher.

The following officers were elected and installed for the ensuing year:

President—Mr. George R. Stetson.

Vice-president—Dr. John R. Swanton.

Secretary—Dr. Daniel Folkmar.

Treasurer—Mr. J. N. B. Hewitt.

Councillors—Mr. George C. Maynard, Mr. Felix Neumann, Dr. I. M. Casanowicz, Dr. E. L. Morgan and Mr. Francis LaFlesche.

Invitations to meetings of the National Academy of Sciences and the German Anthropological Association were presented and accepted with thanks.

Wm. H. Babcock,
Secretary

④ SCIENCE

FRIDAY, JUNE 13, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

CONCERNING THE FIGURE AND THE DIMENSIONS OF THE UNIVERSE OF SPACE[1]

THERE is something a little incongruous in attempting to consider the subject of this address in a theater or lecture hall whose roof and walls shut out from view the wide expanses of the world and the azure deeps. For how can we, amid the familiar finite scenes of a closed and blinded room, command a fitting mood for contemplating the infinite scenes without and beyond? A subject that has sheer vastness for its central or major theme demands for its appropriate contemplation the still expanse of some vast and open solitude, such as the peak of a lone and lofty mountain would afford, where the gaze meets no wall save the far horizon and no roof but the starry sky. Perhaps you will be good enough for the time to transport yourselves, in imagination, into the stillness of such a solitude, so that in the musing spirit of the place the questions to be propounded for consideration here may arise naturally and give us a due sense of their significance and impressiveness. What are the dimensions and what is the figure of our universe of space? How big is it and what is its shape? What is the figure of it and what is its size?

I do not mind owning that these questions have haunted me a good deal from the days of my youth. It happened in

[1] An address delivered under the auspices of the local chapters of the Society of Sigma Xi at the state universities of Minnesota, Nebraska and Iowa, April 24, 28 and 30, respectively, and at a joint meeting of the chapters of Sigma Xi and Phi Beta Kappa of Columbia University, May 8.

those days, though I was not aware of it nor became aware of it till after many years, that there were then coming into mathematics, just entering the fringe, so to speak, or the vestibule of the science, certain striking ideas which, as I venture to hope we may see, were destined, if not indeed to enable us to answer the questions with certainty, at all events to clarify them, to enrich their meaning and to make it possible to discuss them profitably. It has not been my fortune to meet many persons who had seriously propounded the questions to themselves or who seemed to be immediately interested in them when propounded by others—not many, even among astronomers, whose minds, it may be assumed, are specially "accustomed to contemplation of the vast." And so I have been forced to the somewhat embarrassing conclusion that my own long interest in the questions has been due to the fact of my being of a specially practical turn of mind. Quite seriously I venture to say that we are here engaged in a practical enterprise. For even if the questions were in the nature of the case unanswerable, which we do not admit, who does not know how great the boons that have come to men through pursuit of the unattainable? And who does not know that, as Mr. Chesterton has said, if you wish really to know a man, the most practical question to ask is, not about his occupation or his club membership or his party or church affiliations, but what are his views of the all-embracing world? What does he think of the universe? Do but fancy for a moment that in somewise men should come to *know* the exact shape or figure and especially the exact size or dimensions of the all-immersing space of our universe. It requires but little imagination, not much reflection, no extensive knowledge of cosmogonic history and speculation, no very profound insight into the ways of truth to men; it needs, I say, but little philosophic sense to see that such knowledge would in a thousand ways, direct and indirect, react powerfully upon our whole intelligence, upon all our attitudes, sentiments and views, transforming our theology, our ethics, our art, our religion, our philosophy, our literature, our science, and therewith affect profoundly the whole sense and manner, the tone, color and meaning, of all our institutions and the affairs of daily life. Nothing is quite so practical, in the sense of being effectual and influential, as the views men hold, consciously or unconsciously, regarding the great locus of their lives and their cosmic home.

In order to discuss the questions before us intelligibly and profitably it is not necessary by way of clearing the ground to enter far into metaphysical speculation or into psychological analysis with a view to ascertaining what it is that we mean or ought to mean by space. We are not obliged to dispute, much less decide, whether space is subjective or objective or both or indeed something that, as Plato in the "Timæus" acutely contends, is neither the one nor the other. We may or may not agree with the contention of Kant that space is, not an object, but the form, of outer sense; we may or may not agree with the radically different contention of Poincaré that (geometric as distinguished from sensible) space is nothing but what is known in mathematics as a group, of which the concept "is imposed on us, not as form of our sense, but as form of our understanding." It is, I say, not necessary for us, in the interest of soundness and intelligibility, to try to compose such differences or to attempt a settlement of these profound and important questions. As to the distinction between

sensible space and geometric space, it would indeed be indispensable to draw it sharply and to keep it always in mind, if we were undertaking to ascertain what the subject (or the object) of geometry is, or, what is tantamount, if we were seeking to get clearly aware of what it is that geometry is about. But in discussing the subject before us it is unnecessary to be always guarding that distinction; for, whilst it is the space of geometry, and not sensible space, that we shall be talking about, yet it would be a hindrance rather than a help if we did not allow, as we habitually do allow, the two varieties of space—the imagery of the one, the conceptual characters of the other—to mingle freely in our thinking. There will be finesse enough for the keenest arrows of our thought without our going out of the way to find it. A procedure less sophisticated will suffice. It will be sufficient to regard space as being what, to the layman and to the student of natural science, it has always seemed to be: a vast region or room round about us, an immense exteriority, locus of all suspended and floating objects of outer sense, the whence, where and whither of motion, theater, in a word, of the ageless drama of the physical universe. In naturally so construing the term we do not commit ourselves to the philosophy, so-called, of common sense; we thus merely save our discourse from the encumbrance of needless refinements; for it is obvious that, if space be not indeed what we have said it seems to be, the seeming is yet a fact, and our questions would remain without essential change: what, then, we should ask, are the dimensions and what is the figure of that seeming?

Though all the things contained within that triply extended spread or expanse which we call space are subject to the law of ceaseless change, the expanse itself, the container of all, appears to suffer no variation whatever, but to be, unlike time, a genuine constant, the same yesterday, to-day and forever, sole absolute invariant under the infinite host of transformations that constitute the cosmic flux. Whether it be so in fact, of course we do not know. We only know that no good reason has ever been advanced for holding the contrary as an hypothesis.

And yet there is a sense, which we ought I think to notice, an interesting sense, in which space seems to be, not a constant, but, like time, a variable. There is a sense, deeper and juster perhaps than at first we suspect, in which the space of our universe has in the course of time alternately shrunken and grown. During the last century, for example, it has, so it seems, greatly grown, in response, it may be, to an increasing need of the human mind. By grown I do not mean grown in the usual sense, I do not mean the biological sense, I do not mean the sense that was present to the mind of that great man, Leonardo da Vinci, when he wrote in effect as follows: if you wish to know that the earth has been growing, you have only to observe "how, among the high mountains, the walls of ancient and ruined cities are being covered over and concealed by the earth's increase"; and, if you would learn how *fast* the earth is growing, you have only to set a vase, filled with pure earth, upon a roof; to note how green herbs will immediately begin to shoot up; to note that these, when mature, will cast their seeds; to allow the process to continue through repetition; then, after the lapse of a decade, to measure the soil's increase; and, finally, to multiply, in order to have thus determined "how much the earth has grown in the course of a thousand years." In this matter, Leo-

nardo was doubtless wrong. At all events current scientific views are against him. The earth, we know, has grown, but the growth has been by accretion, by addition from without, and not, in biologic sense, by expansion from within (unless, indeed, we adopt the beautiful hypothesis of the poet and physicist, Theodor Fechner, for which so hard-headed a scientific man as Bernhardt Riemann had so much respect, the hypothesis, namely, that the plants, the earth and the stars have souls). The myriad-minded Florentine was, we of to-day think, in error, his error being one of those brilliant mistakes that but few men have been qualified to make. But in saying that space has grown we do not mean that it has grown in the biologic sense of Leonardo nor yet in the sense of addition from without. We mean that it has grown as a thing in mind may grow, as a thing in thought may grow; we mean that it has grown in men's conception of it. That space has, in this sense, been enlarged prodigiously in the course of recent time is evident to all. It has been often said that the first grand discovery of modern times is the immense extension of the universe *in space.*" It would be juster to say that the first grand achievement of modern science has been the immense extension of space itself, the prodigious enlargement of it, in the imagination and especially in the thought of men. If we will but take the trouble to recall vividly the Mosaic cosmogony, in terms of which most of us have but recently ceased to frame our sublimest conceptions of the vast; if we remind ourselves of Plato's "concentric crystal spheres, the adamantine axis turning in the lap of necessity, the bands that held the heaven together like a girth that clasps a ship, the shaft which led from earth to sky, and which was paced by the soul in a thousand years"; if we compare these conceptions with our own; if we think of "the fields from which our stars fling us their light," fields that are really near and yet are so far that the swiftest of messengers, capable of circling the earth eight times in a second, requires for its journey hither thousands of years; if we do but make some such comparisons, we shall begin to realize dimly that, compared with modern space—the space of modern thought—elder space—the space of elder thought—is indeed "but as a cabinet of brilliants, or rather a little jewelled cup found in the ocean or the wilderness."

Suppose that in fact space were thus, like time, not a constant, but a variable; suppose it were a mental thing growing with the growth of mind; an increasing function of increasing thought; suppose it were a thing whose enlargement is essential as a psychic condition or concomitant or effect of the progress of science; would not our questions regarding its figure and its dimensions then lose their meaning? The answer is, no; as rational beings we should still be bound to ask: what are the dimensions and what is the figure of space to date? That is not all. If these questions were answered, we could propound the further questions: whether the space so characterized—the space of the present—is adequate to the present needs of science, and whether it is not destined to yet further expansion in response to the future needs of thought.

Men do not feel, however, that such spatial enlargements as I have indicated are genuine enlargements of space. In spite of whatever metaphysics or psychology may seem obliged to say to the contrary, men feel that what is *new* in such an enlargement is merely an increase of enlightenment regarding something old; they

feel that what is new is, not an added vastness, but a discovery of a vastness that always was and always will be. Let us trust this feeling and, regarding space as constant from everlasting to everlasting, let us take the questions in their natural intent and form: what are the dimensions and what is the figure of our universe of space?

If you propound these questions to a normal student of natural science, say to a normal astronomer, his response will be—what? If you appear to him to be quite sincere and if, besides, he be in an amiable mood, his response will, not improbably, be a significant shrug of the shoulders, designed to intimate that his time is too precious to be squandered in considering questions that, if not meaningless, are at all events unanswerable. I maintain, on the contrary, that this same student of natural science and, indeed, all other normally educated men and women, have, as a part of their intellectual stock in trade, perfectly definite answers to both of the questions. I do not mean that they are aware of possessing such wealth nor shall I undertake to say in advance whether their answers be correct. What I am asserting and what, with your assistance, I shall endeavor to demonstrate, is that perfectly precise, very intelligent and perfectly intelligible answers to both of the questions are logically involved in what every normally educated mind regards as the securest of its intellectual possessions. In order to show that such answers are to be found embedded in the content of the normally educated mind and in order to lay them bare, it will be necessary to have recourse to the process of explication. Explication, however, is nothing strange to an academic audience. It is true, indeed, that we no longer derive the verb, to educate, from *educere*, but it is yet a fact, as every one knows, that a large part of education is *eduction*—the leading forth into light what is hidden in the familiar content of our minds.

What are those answers? I shall present them in the familiar and brilliant words of one who in the span of a short life achieved a seven-fold immortality: immortality as a physicist, as a philosopher, as a mathematician, as a theologian, as a writer of prose, as an inventor and as a fanatic. From this brief but "immortal" characterization I have no doubt that you detect the author at once and at once recall the words: *Space is an infinite sphere whose center is everywhere and whose surface is nowhere.*

You will observe that, without change of meaning, I have substituted "space" for "universe" and "surface" for "circumference." This brilliant *mot* of Blaise Pascal, as every one knows, has long been valued throughout the world as a splendid literary gem. I am not aware that it has been at any time regarded seriously as a scientific thesis. It may, however, be so regarded. I propose to show, with your cooperation, that this exquisite saying of Pascal expresses with mathematical precision the firm, albeit unconscious, conviction of the normally educated mind respecting the size and the shape of the space of our universe. Be good enough to note carefully at the outset the cardinal phrases: *infinite sphere, center everywhere, surface nowhere.*

If you are told that there is an object completely enclosed and that the object is equally distant from all parts of the enclosing boundary or wall, you instantly and rightly think of a sphere having that object as center. Let me ask you to think of some point, any convenient point, *P*, together with all the straight lines or rays—called a sheaf of lines or rays—that, beginning at *P*, run out from it as far as ever the nature of space allows. We ask: do all the rays of the sheaf run out equally far? It seems

perfectly evident that they do, and with this we might be content. It will be worth while, however, to examine the matter a little more attentively. Denote by L any chosen line or ray of the sheaf. Choose any convenient unit of length, say a mile. We now ask: how many of our units, how many miles can we, starting from P, lay off along L? Lay off, I mean, not in fact, but in thought. In other words: how many steps, each a mile long, can we, in traversing L, take in thought? Hereafter let the phrase "in thought" be understood. Can the question be answered? It can. Can it be answered definitely? Absolutely so. How? As follows. Before proceeding, however, let me beg of you not to hesitate or shy if certain familiar ideas seem to get submitted to the logical process—the mind-expanding process—of generalization. There is to be no resort to any kind of legerdemain. Let us be willing to transcend imagination, and, without faltering, to follow thought, for thought, free as the spirit of creation, owns no bar save that of inconsistence or self-contradiction. Consider the sequence of cardinal numbers,

$$(S)\quad 1, 2, 3, 4, 5, 6, 7, \ldots.$$

The sequence is neither so dry nor so harmless as it seems. It has a beginning; but it has no end, for, by the law of its formation, after each term there is a next. The difference between a sequence that stops somewhere and one that has no end is awful. No one, unless spiritually unborn or dead, can contemplate that gulf without emotions that take hold of the infinite and everlasting. Let us compare the sequence with the ray L of our sheaf. Choose in (S) any number n, however large. Can we go from P along L that number n of miles? We are certain that we can. Suppose the trip made, a mile post set up and on it painted the number n to tell how far the post is from P. As n is any number in (S), we may as well suppose, indeed we have already implicitly supposed, mile posts, duly distributed and marked, to have been set up along L to match each and every number in the sequence. Have we thus set up all the mile posts that L allows? We are certain that we have, for, if we go out from P along L any possible but definite number of miles, we are perfectly certain that that number is a number in the sequence, and that accordingly the journey did but take us to a post set up before. What is the upshot? It is that L admits of precisely as many mile posts as there are cardinal numbers, neither more nor less. How long is L? The answer is: L is exactly as many miles long as there are integers or terms in the sequence (S). Can we say of any other line or ray L' of the sheaf what we have said of L? We are certain that we can. Indeed we have said it, for L was *any* line of the sheaf. May we, then, say that any two lines, L and L', of the sheaf are *equal*? We may and we must. For, just as we have established a one-to-one correspondence between the mile posts of L and the terms of (S), so we may establish a one-to-one correspondence between the mile posts of L and those of L', and what we mean by the *equality* of two classes of things is precisely the possibility of thus setting up a one-to-one correlation between them. Accordingly, all the lines or rays of our sheaf are equal. We can not fail to note that thus there is forming in our minds the conception of a sphere, centered at P, larger, however, than any sphere of slate or wood or marble—a sphere, if it be a sphere, whose radii are the rays of our sheaf. Is not the thing, however, too vast to be a sphere? Obviously yes, if the lines or rays of the sheaf have a length that is indefinite, unassignable; obviously no, if their length be assignable and definite. We have

seen the length of a ray contains exactly as many miles as there are integers or terms in (S). The question, then, is: has the totality of these terms a definite assignable number? The answer is, yes. To show it, look sharply at the following fact, a bit difficult to see only because it is so obvious, being writ, so to speak, on the very surface of the eye. I wish, in a word, to make clear what is meant by the cardinal number of any given class of things. The fingers of my right hand constitute a class of objects; the fingers of my left hand, another class. We can set up a one-to-one correspondence between the classes, pairing the objects in the one with those in the other. Any two classes admitting of such a correlation are said to be *equivalent*. Now given any class K, there is another class C composed of all the classes each of which is equivalent to K. C is called the cardinal number of K, and the name of C, if it have received a name, tells how many objects are in K. Thus, if K is the class of the fingers of my right hand, the word *five* is the name of the class of classes each equivalent to K. Now to the application. The terms of (S) constitute a class K (of terms). Has it a definite number? Yes. What is it? It is the class of all classes each equivalent to K. Has this number-class received a name of its own? Yes, and it has, like many other numbers, received a symbol, namely, $\aleph_0$, read Aleph null. It is, then, this cardinal number Aleph, not familiar, indeed, but perfectly definite as denoting a definite class, it is this that tells us how many terms are in (S) and therewith tells us the length of the rays of our sheaf. Herewith the concept that was forming is now completely formed: *space is a sphere centered at P*.

But is the sphere, as Pascal asserts, an *infinite* sphere? We may easily see that it is. Again consider the sequence (S) and with it the similar sequence (S'),

$$(S)\quad 1,\ 2,\ 3,\ 4,\ 5,\ 6,\ 7,\ \cdots,$$
$$(S')\quad 2,\ 4,\ 6,\ 8, 10, 12, 14,\ \cdots.$$

Observe that all the terms in (S') are in (S) and that (S) contains terms that are not in (S'). (S') is, then, a proper *part* of (S). Next observe that we can pair each term in (S) with the term below it in (S'). That is to say: the whole, (S), is equivalent to one of its parts, (S'). A class that thus has a part to which it is equivalent is said to be infinite, and the number of things in such a class is called an infinite number. Aleph is, then, an infinite number, and so we see that the rays of our sheaf, the radii of our sphere, are infinite in length: *space is an infinite sphere entered at P*.

Finally, what of the phrases, *center everywhere, surface nowhere?* Can we give them a meaning consistent with common usage and common sense? We can, as follows. Let O be any chosen point somewhere in your neighborhood. By saying that the center P is everywhere we mean that P may be taken to be *any* point within a sphere centered at O and having a finite radius, a radius, that is, whose length in miles is expressed by any integer *in* (S). And by saying that the surface of our infinite sphere is nowhere we mean that no point of the surface can be reached by traveling out from P any *finite* number, however large, of miles, by traveling, that is, a number of miles expressed by any number, however large, in (S).

Here we have touched our primary goal: we have demonstrated that men and women whose education, in respect of space, has been of normal type, believe profoundly, albeit unawares, that the space of our universe is an infinite sphere of which the center is everywhere and the surface nowhere. Such is the beautiful conception,

the great conception—mathematically precise yet mystical withal and awful in its limitless reaches—which is ever ready to form itself, in the normally educated mind and there to stand a deep-rooted conscious conviction regarding the shape and the size of the all-embracing world.

Is the conception valid? Does the conviction correspond to fact? Is it true? It is not enough that it be intelligible, which it is; it is not enough that it be noble and sublime, which also it is. No doubt whatever is noble and sublime is, in some sense, true. For we mortals have to do with more than reason. Yet science, science in the modern technical sense of the term, having elected for its field the domain of the rational, allows no superrational tests of truth to be sufficient or final. We must, therefore, ask: are the dimensions and the figure of our space, in fact, what, as we have seen, Pascal asserts and the normally educated mind believes them to be? Long before the days of Pascal, back yonder in the last century before the beginning of the Christian era, one of the acutest and boldest thinkers of all time, immortal expounder of Epicurean thought, answered the question with the utmost confidence in the affirmative. I refer to Lucretius and his "De Rerum Natura." In my view that poem is the greatest and finest union of literary excellence and scientific spirit to be found in the annals of human thinking. I maintain that opinion of the work despite the fact that the majority of its conclusions have been invalidated by time, have perished by supersession; for we must not forget that, in respect of knowledge, "the present is no more exempt from the sneer of the future than the past has been." I maintain that opinion of the work despite the fact that the enterprise of Lucretius was marvelously extravagant; for we must not forget that the relative modesty of modern men of science is not inborn, but is only an imperfectly acquired lesson. Well, it is in that great work that Lucretius endeavors to prove that our universe of space is infinite in the sense that we have explained. His argument, which runs to many words, may be briefly paraphrased as follows. Conceive that, starting from any point of space, you go out in any direction as far as you please, and that then you hurl your javelin. Either it will go on, in which case there is space ahead for it to move in, or it will not go on, in which case there must be space ahead to contain whatever prevents its going. In either case, then, however far you may have gone, there is yet space beyond. And so, he concludes, space is infinite, and he triumphantly adds:

> Therefore the nature of room and the space of the unfathomable void are such as bright thunderbolts can not race through in their course though gliding on through endless tract of time, no nor lessen one jot the journey that remains to go by all their travel—so huge a room is spread out on all sides for things without any bounds in all directions round.

Such is the argument, the great argument, of the Roman poet. Great I call it, for it is great enough to have fooled all philosophers and men of science for two thousand years. Indeed only a decade ago I heard the argument confidently employed by an American thinker of more than national reputation. But is the argument really fallacious? It is. The conclusion may indeed be quite correct—space may indeed be infinite, as Lucretius asserts—but it does not follow from his argument. To show the fallacy is no difficult feat. Consider a sphere of finite radius. We may suppose it to be very small or intermediate or very large—no matter what its size so long as its radius is finite. By sphere, in this part of the discussion, I shall mean sphere-surface. Be good enough

to note and bear that in mind. Observe that this sphere—this surface—is a kind of room. It is a kind of space, region or room where certain things, as points, circle arcs and countless other configurations can be and move. These things, confined to this surface, which is their world, their universe of space, if you please, enjoy a certain amount, an immense amount, of freedom: the points of this world can move in it hither, thither and yonder; they can move very far, millions and millions of miles, even in the same direction, if only the sphere be taken large enough. I see no reason why we should not, for the sake of vividness, fancy that spherical world inhabited by two-dimensional intelligences conformed to their locus and home just as we are conformed to our own space of three dimensions. I see no reason why we should not fancy those creatures, in the course of their history, to have had their own Democritus and Epicurus, to have had their own Roman republic or empire and in it to have produced the brilliant analogues of our own Vergil, Cicero and Lucretius. Do but note attentively—for this is the point—that their Lucretius could have said about their space precisely what our own said about ours. Their Lucretius could have said to his fellow-inhabitants of the sphere: "starting at any point, go as far as ever you please in any straight line"—such line would of course (as *we* know) be a great circle of the sphere—"and then hurl your javelin"—the javelin would, as *we* know, be only an *arc* of a great circle—"either it will go on, in which case, etc.; or it will not, etc."; thus giving an argument identical with that of our own Lucretius. But what could it avail? *We* know what would happen to the javelin when hurled as supposed in the surface: it would go on for a while, there being nothing to prevent it. But whether it went on or not, it could not be logically inferred that the surface, the space in question, is infinite, for we know that the surface is finite, just so many, a finite number of, square miles. The fallacy, at length, is bare. It consists—the fact has been recently often pointed out—in the age-long failure to distinguish adequately between *unbegrenzt* and *unendlich*—between *boundless* and *infinite* as applied to space. What our fancied Lucretius proved is, if anything, that the sphere is boundless, but not that it is infinite. What our real Lucretius proved is, if anything, that the space of our universe is boundless, but not that it is infinite. That a region or room may be boundless without being infinite is clearly shown by the sphere (surface). How evident, once it is drawn, the distinction is. And yet it was never drawn, in thinking about the dimensions of space, until in 1854 it was drawn by Riemann in his epoch-marking and epoch-making *Habilitationschrift* on the foundations of geometry.

What, then, is the fact? Is space finite, as Riemann held it may be? Or is it infinite, as Lucretius and Pascal deliberately asserted, and as the normally educated mind, however unconsciously, yet firmly believes? No one knows. The question is one of the few great outstanding scientific questions that intelligent laymen may, with a little expert assistance, contrive to grasp. Shall we ever find the answer? Time is long, and neither science nor philosophy feels constrained to haul down the flag and confess an *ignorabimus*. Neither is it necessary or wise for science and philosophy to camp indefinitely before a problem that they are evidently not yet equipped to solve. They may proceed to related problems, always reserving the right to return with better instruments and added light.

In the present instance, let us suppose,

for the moment, that Lucretius, Pascal and the normally educated mind are right: let us suppose that space is infinite, as they assert and believe. In that case the bounds of the universe are indeed remote, and yet we may ask: are there not ways to pass in thought the walls of even so vast a world? There are such ways. But where and how? For are we not supposing that the walls to be passed are distant by an amount that is infinite? And how may a boundary that is infinitely removed be reached and overpassed? The answer is that there are many infinites of many orders; that infinites are surpassed by other infinites; that infinites, like the stars, differ in glory. This is not rhetoric, it is naked fact. One of the grand achievements of mathematics in the nineteenth century is to have defined infinitude (as above defined) and to have discovered that infinites rise above infinites, in a genuine hierarchy without a summit. In order to show how we can in thought pass the Lucretian and Pascal walls of our universe, I must ask you to assume as a lemma a mathematical proposition which has indeed been rigorously established and is familiar, but the proof of which we can not tarry here to reproduce. Consider all the real numbers from *zero* to *one* inclusive, or, what is tantamount, consider all the points in a unit segment of a continuous straight line. The familiar proposition that I am asking you to assume is that it is not possible to set up a one-to-one correspondence between the points of that segment and the positive integers (in the sequence above given), but that, if you take away from the segment an infinitude (Aleph) of points matching all the positive integers, there will remain in the segment more points, infinitely more, than you have taken away. That means that the infinitude of points in the segment infinitely surpasses the infinitude of positive integers; surpasses, that is, the infinitude of mile posts on the radius of our infinite (Pascal) sphere. Now conceive a straight line containing as many miles as there are points in the segment. You see at once that in that conception you have overleaped the infinitely distant walls of the Lucretian universe. Overleaped, did I say? Nay, you have passed beyond those borders by a distance infinitely greater than the length of any line contained within them. And thus it appears that, not our imagination, indeed, but our reason may gaze into spatial abysses beside which the infinite space of Lucretius and Pascal is but a meager thing, infinitesimally small. There remain yet other ways by which we are able to escape the infinite confines of this latter space. One of these ways is provided in the conception of hyperspaces enclosing our own as this encloses a plane. But that is another story, and the hour is spent.

The course we have here pursued has not, indeed, enabled us to answer with final assurance the two questions with which we set out. I hope we have seen along the way something of the possibilities involved. I hope we have gained some insight into the meaning of the questions and have seen that it is possible to discuss them profitably. And especially I hope that we have seen afresh, what we have always to be learning again, that it is not in the world of sense, however precious it is and ineffably wonderful and beautiful, nor yet in the still finer and ampler world of imagination, but it is in the world of conception and thought that the human intellect attains its appropriate freedom—a freedom without any limitation save the necessity of being consistent. Consistency, however, is only a prosaic name for a limitation which, in

another and higher realm, harmony imposes even upon the muses.

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CLINICAL PSYCHOLOGY: WHAT IT IS AND WHAT IT IS NOT

ON an occasion like this[1] it would seem proper, representing as I do one of the newest of the sciences, that I address myself to some of the basic questions of this science. Perhaps the very first question with which one is confronted is simply this: "In view of the rapid multiplication of the sciences, by what right does clinical psychology lay claim to an independent existence?" That is a question which may perturb some sensitive minds, but it does not disconcert the clinical psychologist, for he regards the question as perfectly legitimate and capable of satisfactory answer.

It is just and proper that a new claimant to membership in the family of sciences should be required to present her credentials. It is a natural human trait to challenge or contest the claims of a newcomer. It has ever been thus. Every branch of knowledge before winning recognition as an independent science has been forced to demonstrate that it possesses *a distinct and unique body of facts* not adequately treated by any other existing science; or that it approaches the study of a *common body* of facts from a *unique* point of view, and with methods of its own. Psychology, biochemistry, dentistry, eugenics, historiometry and many other sciences have been thus obliged to fight their way inch by inch to recognition as independent sciences. It is not long since physiology claimed psychology as its own child and stoutly contested her rights to existence; nor is it long since medicine denied any right to independent existence to dentistry. It is no surprise that a number of sciences now claim clinical psychology as part and parcel of their own flesh and blood, and that they deny her the right to "split off from the parent cell" and establish an unnursed existence of her own. Just as nature abhors a vacuum, so science abhors the multiplication of sciences; just as the big corporation octopus in the industrial world tries to get monopolistic control of the sources of production and distribution, so the various sciences, naturally insatiable in their desire for conquest, attempt only too often to get monopolistic control of all those elements of knowledge which they may be able to use for their own aggrandizement, whether or not they have developed adequate instruments for scientifically handling those elements.

Clinical psychology, however, is quite ready to contest the attempts to deprive her of her inalienable rights to the "pursuit of life and happiness." Fundamentally, she bases her claims to recognition as an independent science on the fact that

[1] Substance of an address delivered before the Conference on the Exceptional Child, held under the auspices of the University of Pittsburgh, April 16, 1912. Lest misapprehensions arise, it should be clearly understood that in this discussion I am concerned only with the relation of *clinical psychology* to *mentally* exceptional school children; and that I distinctly recognize a different type of exceptional children, namely, the *physical* defectives. The physical defectives should be examined by skilled pediatricians. The clinical psychologist is interested in physically exceptional children if they manifest mental deviations. Moreover, while I hold that the psycho-clinical laboratories must become the clearing houses for all types of *mentally* or *educationally* exceptional children in the schools, nearly all mentally exceptional children should be given a physical examination by consulting or associated medical experts. Physical abnormalities should, of course, be rectified, whether or not it can be shown that they sustain any causal relation to any mental deviations which may have been disclosed in the psycho-clinical examination. They may claim treatment in their own right.

she *does* possess a unique body of facts not adequately handled by any existing science, and that she investigates these facts by methods of her own. These facts consist of *individual mental variations*, or the phenomena of *deviating or exceptional mentality*. In other words, clinical psychology is concerned with the *concrete* study and examination of the behavior of the *mentally exceptional individual* (not groups), by its own methods of observation, testing and experiment.

In the study or examination of individual cases, the clinical psychologist seeks to realize four fundamental aims:

1. *An Adequate Diagnosis or Classification.*—He attempts to give a correct description of the nature of the mental deviations shown by his cases; he tries to determine whether they are specific or general, whether they affect native or acquired traits; he attempts to measure by standard objective tests the degree of deviation of various mental traits or of the general level of functioning; he seeks to arrive at a comprehensive clinical picture, to disentangle symptom-complexes and to reduce the disorders to various reaction types.

2. *An Analysis of the Etiological Background.*—His examination is bent not only on determining the present mental status of the case, but on discovering the causative factors or agents which have produced the deviations—whether these factors are physical, mental, social, moral, educational, environmental or hereditary. In order to arrive at a correct etiology the psycho-clinician makes not only a cross-section analysis of the case, but also a longitudinal study of the evolution of the deviation or symptom-complex. Therefore he does not limit himself merely to a psychological examination, but requires a dento-medical examination and a sociological and hereditary examination. The physical examination should be made by experts in dentistry and in the various specialties in the field of medicine. The psycho-clinicist, however, should be so trained in physical diagnosis that he can detect the chief physical disorders, so that he can properly refer his cases for expert physical examination.

3. A determination of the *modification* which the disorder has wrought in the *behavior of the individual*. He should determine what its consequences have been: what effects it has had upon his opinions, beliefs, thoughts, disposition, attitudes, interests, habits, conduct, capacity for adaptation, learning ability, capacity to acquire certain kinds of knowledge or various accomplishments, or to do certain kinds of school work. He should seek to locate the conflicts between instincts and habits which may have been caused by the deviations.

4. The determination of the *degree of modifiability* of the variations discovered. Can the deviations be corrected or modified, and if so to what extent and by what kinds of orthogenic measures? A clinical psychologist is no less a scientific investigator than a consulting specialist; he diagnoses in order to prognose and prescribe. His aim first and last is eminently practical.

BASIS OF SELECTION OF CASES

The clinical psychologist selects his cases not so much on the nature of the cause of the deviations as on the nature of the deviations themselves, and the nature of the treatment. He is interested in cases which, first of all, depart from the limits of mental normality. *Exceptional mentality*, or, if you please, *mental exceptionality*, is his first criterion. In the second place, he is interested in those cases in which the nature of the treatment—the *process of righting* the mental variations, of straightening out the deviations, the orthogenesis—

is wholly or chiefly or partly *educational*. In the term educational I include training of a hygienic, physiological (in Seguin's sense), pedagogical, psychological, sociological or moral character.

GROUPING OF CASES

It is thus evident that the clinical psychologist may group his cases into two main classes.

A. Those in which the *mental variations are fundamental* or primary, and the physical disabilities only accessory or sequential. With these cases the treatment must be primarily educational and only secondarily medical. What types of children are included in this group?

I. *Feeble-minded Children*.—Feeble-mindedness formerly was regarded as an active disorder—a disease—and was accordingly treated exclusively medically. The theory of causation was wrong and so the results were unsatisfactory. Since the year 1800 (Itard, the apostle to the feeble-minded) and particularly since the year 1837 (Seguin, the liberator of the feeble-minded), it has become increasingly apparent that feeble-mindedness is an arrest of development; and accordingly since that time the condition has been primarily educationally treated instead of medically. This change in point of view has revolutionized the treatment of the feeble-minded. The person who did most to ameliorate their condition is Seguin, whose method, almost entirely educational, has served as the model for the effective institutional work for the feeble-minded done since his day, although we have outgrown various details of his system. Moreover, it served as the chief inspiring force for the constructive orthogenic work done for the feeble-minded within the last decade or so by Montessori. She, herself a physician, but with special training in psychology and pedagogy, tells us that in 1898 as a result of a careful study of the problem of feeble-mindedness she became persuaded that the problem was primarily a pedagogical and not a medical one. It is granted without question, of course, that there is a medical side to the care of the feeble-minded just as there is a medical side to the care of the normal child. Nay, owing to the heightened degree of susceptibility to disease and accidents found among the feeble-minded, the medical side looms larger in the care of the feeble-minded than in the care of normals. Indeed, no institution for the feeble-minded can be properly organized without an adequate staff of medical experts; but fundamentally the problem of the amelioration of the lot of feeble-minded children is an educational one—their hygienic, pedagogical and moral improvement, as well as their elimination by the method of colonization or sterilization.

II. *Retardates*, technically so-called—of which there are probably on a conservative estimate 6,000,000 in the schools of the United States. Some of these are retarded (1) merely pedagogically in a relative sense—relative to an *arbitrary curricular standard*. Many children do not fit the standard, because the standard itself is off the norm. It is largely a case of a misfit curriculum instead of a misfit child. So far as this class of misfits is concerned the problem is simply one of correct adjustment of the pedagogical demands of the curriculum.

A considerable percentage of the retardates, however, are retarded because of (2) *genuine mental arrest of development*. They are as truly arrested or deficient as the feeble-minded, but to a *lesser extent*. The difference is a *quantitative* and not a qualitative one, and the problem of correc-

tion consists fundamentally in providing a right educational regimen.

Then there is (3) a smaller proportion of retardates who are mentally retarded because of *environmental handicaps*, such as bad housing, home and neighborhood conditions, bad sanitation, lack of humidity, lack of pure air or excessive temperature in the schoolroom, vicious or illiterate surroundings, frequent moving or transfer, emigration which may cause linguistic maladaptation, etc. With such retardates the problem is partly sociological, partly hygienic, and partly pedagogical.

We have a final group of children (4) who are mentally retarded because of some *physical defect*. With children of this type the problem is partly medical and partly educational. The first efforts made in behalf of such children should be medical and hygienic. Undoubtedly the removal of physical handicaps will restore some pupils to normal mentality, while in the case of other pupils the results will be negative. Unfortunately there are very few scientific studies available of the orthophrenic effects of the correction of physical defects.[2] Many of the studies in this field have a questionable value because of the obvious, but evidently unconscious, bias of the investigators. Some desire to show favorable results and, therefore, unconsciously select only the favorable cases; others are swayed by the opposite motive and accordingly tend to select the negative cases. Hence, at the present time we find considerable diversity of opinion as to the orthogenic influences of the correction of physical disorders. The opinion of John J. Cronin, M.D., probably approximates the truth:

> The successes simply mean that a large number of children were perfect except for some one abnormality. . . . The alleviation of any single kind of physical handicap is merely one step towards the successful result sought, and many other factors must obtain before some measure of success is assured.

Likewise A. Emil Schmitt, M.D.:

> It should constantly be borne in mind that if every physical defect has been successfully removed the mental unbalance or deficiency can remain unaltered, inasmuch as it was primarily a mental defect and can be reached only by methods of education or psychological treatment.

While I am quite convinced that all mentally retarded children should undergo a careful physical examination, and that such physical corrective measures should be applied as are indicated by expert medical opinion, yet it needs to be re-emphasized that the removal of a physical disability is frequently only the first step toward restoration. If the child has fallen behind pedagogically or mentally, he will in many cases need special pedagogical attention if he is to catch step with the class procession; moreover, after a certain critical age has been passed the removal of physical obstructions exercises only a slight orthophrenic influence, and the reestablishment of effective mental functioning, if it can be done at all, will require the prolonged application of a special corrective pedagogy.

III. *The Super-normals.*—Both of the above types of children come on the minus side of the curve of efficiency. On the other side we find the plus deviates—the bright, brilliant, quick, gifted, talented, precocious children. These children may present no peculiarities on the physical side, if we except the type of nervously unstable, precocious children. With the supernormal

[2] However, see an attempt at the scientific measurement of the orthophrenic effects of the correction of dental defects in J. E. Wallace Wallin's "Experimental Oral Euthenics," *The Dental Cosmos*, 1912, pp. 404–413, 545–566. Also, "Experimental Oral Orthogenics," *The Journal of Philosophy, Psychology and Scientific Methods*, 1912, pp. 290–298.

child the problem is almost entirely an educational one: the introduction of schemes of flexible grading; of fast, slow and normal sections, and of supernormal classes; providing special opportunities for doing specialized work, and a special pedagogy, which should probably be as largely negative as positive. If there is any one child in our scheme of public education which has been neglected more than any other, it is the child of unusual talents. A nation can do no higher duty by its subjects than to provide those conditions which will rescue its incipient geniuses from the dead-level of enforced mediocrity.

IV. *Speech defectives*, particularly the two and one half per cent. (approximately) of stutterers and lispers who encumber our classes. In few fields of scientific research is it possible to find such astonishing diversity of so-called expert opinion as on the question of the causation of stuttering (or stammering). It is claimed to be a gastric, pneumogastric, lung, throat, lip, brain, hypoplastic, nervous and mental disorder. It is said to be a form of epilepsy, a form of hysteria, and a form of mental strife, or repression, between latent and manifest mental contents. Moreover, few writers show such a consummate genius for self-contradiction as writers on stuttering. Before me lies a reprint of a recent dissertation on the "Educational Treatment of Stuttering Children." The writer begins by saying that stuttering is a "pathological condition," a disease, and that therefore its treatment belongs to a specialist on diseases. The disease appears, however, on the second page to be merely "a purely functional neurosis," while on the last page the trouble is nothing more than a "mental one," caused by influences acting on the mind. As a matter of fact, the treatment which the writer recommends is through and through educational and largely psychological. It consists of certain physical exercises, designed not so much to strengthen certain organs as to win the patient's interest and restore his self-confidence; and certain psychotherapeutic and hypnotic exercises.

Waiving for the time being the nature of the cause, we can agree on one thing; namely, that the methods of treating stuttering (and lisping) which have been proved effective are almost exclusively educational. Many of the neurotic symptoms found in the stutterer are the results of mental tension and will disappear with the correction of the stuttering.

V. *Incipient psychotics*, or children who show developmental symptoms of mental disorders or mental alienation. Here we meet with the same controversy between the advocates, on the one hand, of a *somatogenic* theory, and, on the other hand, of a *psychogenic* theory of causation. While it must be admitted that many of the psychoses are certainly organic, others almost as certainly are functional and are produced by idiogenic factors (a view entertained by such well-known psychiatrists as Meyer, Freud, Janet, Dubois, Jones, Prince). Now, irrespective of whether the cause is chiefly physical or mental, it is being recognized by a number of the leading present-day psychiatrists that drug treatment for the majority of the insane, whether juvenile or adult, is secondary to the educational treatment. Instead of merely prescribing physical hygiene for the insane, leading alienists are now prescribing mental hygiene. The cure is being conceived in terms of a process of reeducation. Moreover, so far as concerns the mentally unstable child in the schools, the chief reliance is obviously on hygienic and educational guidance.

B. Cases in which the *physical devia-*

tions are fundamental or primary, and the mental variations sequential, but the remedy partly or chiefly educational. Here we include malnutrition, rickets, marasmus, hypothyroidism, tuberculosis, heart trouble, chorea and similar diseases. In all of these the treatment must be primarily medical, although there should be a special temporary educational regimen for these children. This group also includes the blind and the deaf. But here the treatment is almost wholly educational. The physical defects are incurable, but the mental defects can be partly overcome by proper compensatory educational treatment. The epileptic also must be added to this group. Epilepsy is evidently an active disorder or disease process, although the pathology is wrapped in the deepest obscurity. The epileptics appear like purely medical cases. The medical aspect certainly is important, but the records show that only from 5 to 10 per cent. are curable, and that the attacks can be as readily modified or regulated in most cases by proper hygienic treatment as by drug medication or surgical interference. Even with these unfortunates it can be said that the best results come from a proper medico-educational régimé—colonization, out-door employment, industrial schooling, bathing, etc.

SUMMARY OF IMPORTANT CONCLUSIONS

We are thus brought to the two following conclusions:

1. There is a set of unique facts—facts of individual mental variation—which no existing science has adequately treated. It is with these facts that the work of the clinical psychologist is concerned. Just as psychology became an independent science by demonstrating that it possessed a legitimate claim to a unique world of facts, so clinical psychology is ready to make her declaration of independence and dedicate herself to the investigation of a body of facts—facts of individual mental variation—not hitherto adequately handled by any existing science. It is concerned with the study of individual cases of deviate mentality, particularly with those types which are amenable to improvement or correction by psycho-educational processes.

2. The proper handling of these cases, whether for purposes of examination, recommendation or prescription, can only be done by a *psycho-educational specialist* who possesses a technical knowledge of educational and child psychology, of child hygiene, of the science and art of education, and of various classes of mental defectives or deviates. He should possess a thorough grounding in clinical procedure, particularly in the methods of clinical psychology, while he must also have a certain amount of training in pediatrics, physical diagnosis, neurology and psychiatry. He must be thoroughly skilled in the differential pedagogy appertaining to various types of mentally exceptional children.

C. The Relations of Clinical Psychology—Some Affirmations and Denials.—There is a number of sciences with which clinical psychology is, will be, or should be, closely related, but which are not synonymous with clinical psychology.

1. Clinical psychology is not the same as *psychopathology*. The typical alienist is concerned with the study and treatment of mental disorders (technically called psychoses); the clinical psychologist, on the other hand, is concerned *particularly* (though not solely) with the study of *plus* and *minus deviations* from normal mentality. The alienist works chiefly with adults, the clinical psychologist with children. Few alienists possess any expert knowledge of the literature bearing on child or educational psychology, mental deficiency, retardation or acceleration,

stuttering or lisping, special pedagogy or psycho-clinical methods of testing. An alienist accordingly is not to be considered a specialist on the mentally exceptional child in the schools unless indeed he has supplemented his general medical and psychiatric education with a technical study of the psychological and educational aspects of the problem. The alienist of the future will certainly have to secure a different preparation from that now furnished in the medical schools, if he is to enter the field of pedagogic child study.

Before me lies the report of the department of medical inspection of a large school system. Six hundred retarded children were examined in this department, which is in charge of an alienist, who, as I am told, is an expert on the questions of *adult insanity*, but who has no specialized preparation in the psychology and pedagogy of the mentally defective child. Of these children 49.7 per cent. are recorded as feeble-minded. Applying this figure to the 6,000,000 retardates of the public schools of the country, we get a total feeble-minded school population of 3,000,000. This figure, it need scarcely be said, is monstrously absurd. It is fully ten times too large. Feeble-mindedness and backwardness in children, it must be said, are distinct problems from mental alienation, and require for their satisfactory handling a specialist on mentally deviating children. A high grade feeble-minded child can not be identified merely by some rule-of-thumb system of intelligence tests. Feeble-mindedness involves more than a given degree of intelligence retardation. At the same time, lest I be misunderstood, it should be specially stated that psychiatry and clinical psychology will be mutually helped by a closer union. Clinical psychology has many important facts and a valuable experimental technique to offer to psychopathology, and psychopathology in turn is able to contribute facts of great value, and more particularly an effective clinical method of examination, to clinical psychology. As the idiogenic conception of the causation of various psychoses wins greater recognition, clinical psychology will become more and more indispensable to the psychiatrist. It is certain that the efficiency of the clinical psychologist will be greatly increased by a study of mental alienation—not a study of texts on psychiatry, but a first-hand study in institutional residence of individual cases. Any one intending to do psycho-clinical work with mentally deficient children certainly should spend a year or two in residence at institutions for feeble-minded, epileptic and alienated children. The clinical psychologist should be prepared to recognize cases of incipient mental disorder, so that he will be enabled to select these cases and refer them to a psychiatric specialist for further examination.

2. Clinical psychology is not *neurology*. There are important neurological aspects involved in the study of mentally exceptional children. Mental arrest can be largely expressed in terms of neurological arrest, and a clinical psychologist should have a first-hand knowledge of nerve signs and a practical acquaintance with the methods of neurological diagnosis. His knowledge of neurology should be sufficient to enable him to pick out suspected nervous cases and refer them for expert examination by a neurologist. However, it must be emphasized that neurology touches only one side—though an extremely important side—of the problem of exceptional mentality.

3. Clinical psychology is not synonymous with *general medicine*. The average medical practitioner certainly knows far less about the facts of mental variation in

children than either the psychiatrist or neurologist or even the class-room teacher. This fact should occasion no surprise when it is stated that the study of psychology as a science has been practically ignored in the medical curricula throughout the country. The clinical psychologist, however, as I have already said, should be able to detect the chief physical defects found in school children, so that if the laboratory of the clinical psychologist assumes the function of a clearing house for the exceptional child he may be able to refer all suspected cases to proper medical clinics for expert examination and treatment.

4. Clinical psychology is not *pediatrics*. To be sure, the pediatrician deals with children. But his attention is focused on the physical abnormalities of infants; his interest in the phenomena of mental exceptionality is liable to be incidental or perfunctory. In fact, one may read some texts on pediatrics from cover to cover without so much as arriving at a suspicion that there is a body of unique facts converging on the phenomena of departure from the limits of mental normality which require intensive, specialized, expert study and diagnosis. So far as the physical ailments or disabilities of young children are concerned the pediatrician is in a position to render valuable service to the psycho-clinicist; likewise so far as concerns the mental deviations of children the psycho-clinicist is able to render valuable aid to the pediatrician. But one must not confuse pediatrics with clinical psychology.

5. Clinical psychology is not the same as *introspective, educational or experimental psychology*. It differs from these in its method, standpoint and conceptions. While the clinical psychologist should be grounded in introspective and, especially, experimental, educational and child psychology, expertness in these branches of psychology does not in itself confer expertness in practical psycho-clinical work. Such expertness comes only from a technical training in clinical psychology and from a first-hand prolonged study by observation, or experiment, or test of various kinds of mentally exceptional children, particularly the feeble-minded, the epileptic and the retarded. The skilled specialist in experimental or educational psychology or experimental pedagogy, is no more qualified to *clinically* examine mental cases, than is the skilled zoologist, physiologist or anatomist able to *clinically* examine physical cases. Clinical work, both in psychology and medicine, requires clinical training. The assumption that any psychologist or educationist is qualified to do successful psycho-clinical work, after learning how to administer a few mental tests, is preposterous and fraught with the gravest consequences. Clinical psychology can have no standing in the professions as long as we permit this absurd notion to prevail.

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PENSIONS IN THE ROCKEFELLER INSTITUTE

PENSIONS for its members and associate members have been provided by the governing boards of the Rockefeller Institute for Medical Research, and have been financially secured by the generosity of Mr. John D. Rockefeller, who has with this purpose in view increased the endowment of the institute by a gift to it of securities amounting to about $500,000 in value. The pension rules which have been adopted provide three-quarters-pay pensions for members of the institute retiring at the age of 65 after fifteen or more years of service, and pensions of from one half to three quarters of full pay, according to the length of service, for members and associate members who retire at 60 years of age. There is also a provision for total disability after ten

years of service, and for widows and orphaned children, at one half the scale upon which members of the staff are pensioned.

SCIENTIFIC NOTES AND NEWS

AT its commencement exercises last week Columbia University conferred its doctorate of science on Colonel William C. Gorgas, Assistant Surgeon General U. S. A., and Dr. Alexis Carrel, Rockefeller Institute for Medical Research.

THE Medical Society of London, at its meeting on May 19, elected Sir David Ferrier, F.R.S., president, in succession to Sir Watson Cheyne.

DR. V. F. K. BJERKNES, professor of geophysics in the University of Leipzig, and Dr. Hugo Hergesell, president of the International Commission for Scientific Aëronautics, Strasburg, have been elected honorary members of the Royal Meteorological Society.

PROFESSOR GEORGE F. SWAIN, professor of civil engineering in the Graduate School of Applied Science at Harvard University, has been chosen chairman of the Boston Transit Commission to succeed the late George G. Crocker.

PROFESSOR CHARLES J. SMITH, for forty-three years head of the department of mathematics in Western Reserve College and Adelbert College, has presented his resignation and will retire from the faculty at the close of the present college year. He served as professor of mathematics and Perkins professor of natural philosophy and astronomy in Western Reserve College from 1870 to 1882, and as professor of mathematics in Adelbert College from 1882 to the present.

ASSISTANT PROFESSOR J. E. READHIMER, superintendent of experiment fields at the University of Illinois since 1901, has entered on his duties as agricultural adviser in Kane County, Illinois. Professor Readhimer began his work at the university when there were no experiment fields in the state outside of Urbana. He has had a part in a great agricultural development in Illinois. As superintendent he has been intimately connected with the development of the experiment fields. He has seen them increase from one (in Urbana) to thirty-five, scattered over the entire state.

GARDNER C. BASSET, Ph.D., of the Johns Hopkins University, in psychology (1913), has been appointed research assistant in the Eugenics Record Office of the Station for Experimental Evolution at Cold Spring Harbor, and will continue the work on the intelligence of inbred white rats begun at Johns Hopkins.

DR. HARRISON J. HUNT, of Island Falls, Maine, has been appointed surgeon to the Crocker Land Expedition which is leaving for the north polar regions on July 2 next, under the auspices of the American Museum of Natural History, the American Geographical Society and the University of Illinois. Dr. Hunt is a graduate of Bowdoin College and medical school and has had eight years' private practise.

THE C. M. Warren committee of the American Academy of Arts and Sciences has increased to two hundred dollars the award to Professor E. W. Washburn, University of Illinois, for his work on the design of an adiabatic calorimeter. Professor H. B. Byers, University of Washington, has recently published two papers on the passivity of iron, dealing with researches which were in part made possible by grants from the Warren fund. This fund was bequeathed to the academy "for the encouragement and advance of research in the science or field of chemistry" and the committee in charge is glad to know of investigations which may properly be aided by it. Professor H. P. Talbot, Massachusetts Institute of Technology, Boston, Mass., is chairman of the committee.

DR. F. D. BARKER, of the department of zoology of the University of Nebraska, has been voted a grant by the trustees of the Bache fund to enable him to continue his study of the parasitic fauna of the Bermudas. Dr. Barker will spend the latter part of this summer and next summer collecting material at Bermuda.

Dr. A. C. Abbott, Pepper professor of hygiene and bacteriology, University of Pennsylvania, has been appointed a delegate to the fourth International Congress of School Hygiene, to be held at Buffalo, August 25 to 30, next, to represent the University of Pennsylvania and the American Physiological Society.

Mr. N. E. Hansen, secretary of the South Dakota State Agricultural Society, has started on his fourth expedition to Siberia, to gather seed of the Siberian alfalfas which he brought over in 1906 for the first time.

Professor B. E. Livingston will spend the summer at the Desert Laboratory of the Carnegie Institution, at Tucson, Arizona, where he may be addressed from June 20 to September 20.

Professor W. A. Henry, emeritus professor of agriculture at the University of Wisconsin, and for fifteen years dean of the College of Agriculture, is again at the university after a five months' absence. He is planning the preparation of a new book on agriculture.

Dr. E. C. Schroeder, pathologist of the Bureau of Animal Industry, delivered the concluding lecture of the annual series under the auspices of the Ohio State University chapter of the Society of Sigma Xi upon the topic, "Relation of Animal to Human Tuberculosis."

Dr. Oscar Riddle, of the Carnegie Institution, lectured on May 5 under the auspices of the Cornell Chapter of Sigma Xi on "A Relation between the Storage Metabolism of Ova and the Experimental Control of Sex."

The Croonian lecture before the Royal Society was delivered by Dr. Robert Broom, keeper of vertebrate paleontology in the South African Museum, on June 5. The subject was "The Origin of Mammals."

The mathematical works of the late Henri Poincaré are to be published by the firm of Gauthier-Villars, under the auspices of the minister of public instruction and the Paris Academy of Sciences.

Professor Francis T. Havard, associate professor of mining and metallurgy at the University of Wisconsin, died at Madison recently from pneumonia. He was thirty-five years of age and was a native of Australia. He attended universities in Australia and Germany and later had charge of mining interests in South America, Africa and Montana. He became associated with the University of Wisconsin in the fall of 1909.

Professor Heinrich Weber, of Strasburg, died of apoplexy on May 17. He is principally known for his profound work in algebra and at various times was rector of the universities of Koenigsberg, Marburg and Strasburg. His wife, who died a few years ago, translated Poincaré's "La valeur de la science" into German.

The regular annual meeting of the American Chemical Society will be held in Rochester, N. Y., September 9–12, inclusive.

A party of advanced students from the department of geology of the University of Illinois, under the leadership of Dr. John L. Rich, left on June 12 for a two-weeks' geological and geographical excursion through neighboring states. The party planned to proceed east to Richmond, Indiana, and Hamilton, Ohio, where a study will be made of the physiography of the district devastated by the recent floods of the Miami River, thence to Cincinnati. From Cincinnati the party will proceed south into the blue grass district of central Kentucky, west to Mammoth Cave, where a stop of two days will be made, and then return to Urbana through Kentucky and Indiana.

On May 28 an informal meeting was held in the Peabody Museum, Harvard University, and the sod was turned to begin the building of the addition to the Peabody Museum which will complete the entire University Museum as originally planned. A short address written by Professor F. W. Putnam was read by Dr. Charles Peabody. Professor Putnam, unfortunately absent on account of illness, recalled the first ceremony in connection with the beginning of the museum when Governor Banks cut the sod, Professor Louis Agassiz turned it over and Mrs. Agassiz put it into the wheelbarrow. In the present exercises

President Lowell cut the sod which was lifted by Mrs. Henry L. Higginson, a daughter of Professor Louis Agassiz and a sister of the late Professor Alexander Agassiz, '55. After this, George R. Agassiz, '84, and Maximilian Agassiz, '89, followed in turn, as well as a number of other officers of the different departments of the University Museum. The money for the addition has been raised by contribution from friends interested not only in the Peabody Museum, but in the University Museum. The building will be pushed forward with energy and it is hoped that the new space for the collections will be available in the course of nine or ten months.

THE tenth annual session of the Puget Sound Marine Station will convene at Friday Harbor, Washington, on June 23, and will continue for a period of six weeks. The courses to be offered will be as follows: algology, R. B. Wylie, University of Iowa; plant ecology, A. R. Sweetser, University of Oregon; elementary botany, William Moodie, Washington State Normal; elementary zoology, H. B. Duncanson, Nebraska State Normal; general ecology, H. S. Brode, Whitman College; embryology of invertebrates, Wm. J. Baumgartner, University of Kansas; ichthyology, E. V. Smith, University of Washington; advanced ecology, Trevor Kincaid, University of Washington; plankton, John F. Bovard, University of Oregon. Facilities will also be offered for research along botanical and zoological lines. The systematic survey of the local fauna which has been in progress for several seasons will be continued by further deep-water exploration. The director of the station, Professor Trevor Kincaid, of the University of Washington, will be glad to give more extended information to persons planning to visit the laboratory.

UNIVERSITY AND EDUCATIONAL NEWS

MR. ANDREW CARNEGIE has undertaken to provide a million dollars for the medical department of Vanderbilt University. Of this sum $200,000 would be given the university immediately for the erection and equipment of laboratories. The income from the remaining $800,000 would be paid annually for the support of the department through the Carnegie Corporation. A condition of the donation provides that the direction of the educational and scientific work of the department be committed by the board of trustees to a small board of seven members, three of whom shall be eminent in medical and scientific work.

MESSRS. JAMES B. and BENJAMIN N. DUKE have given $800,000 more to Trinity College in North Carolina. The college thus met the $150,000 promised by the Rockefeller Foundation and has added one million dollars to its endowment.

GOVERNOR SULZER has signed a bill appropriating $250,000 for a building for the State College of Agriculture at Syracuse University. Plans for the building are in the hands of the state architect and ground for the building will be broken early in the summer. The building will be located on the western end of the university campus, and when completed will be the largest and best equipped forestry building in the United States. Provision will be made in the basement of the building for laboratories for timber-testing and for investigations in the production of paper pulp and in the destructive distillation of timber. That is, there will be in a simple and miniature way complete paper-making and acid plants. With this will be a very complete wood-working shop where students may get acquainted with woods from the builder's standpoint. Besides offices, class-rooms and laboratories, there will be an auditorium on the third and fourth floors with a seating capacity of 1,000. Such closely related lines as forest botany, forest zoology and forest entomology will be taken care of in especially equipped laboratories.

THAT the University of Wisconsin has 5,970 students at Madison this year and 5,523 enrolled in correspondence-study courses—a total of 11,493—is shown by the new catalogue of the university which came from press this week. Every college in the university except the College of Engineering shows a gain. The College of Agriculture, with a gain of 108 students over last year's enrollment of 748,

making this year's total enrollment 851, shows the largest increase of any division of the university. The College of Letters and Science has an enrollment of 2,528, as compared with 2,504 last year. The course in pharmacy in this college has increased from 38 to 44, and the Medical School from 57 to 66. The course for normal school graduates has a registration of 66 as compared with 58 last year. The course in commerce has 335 students, a loss of 5, while the course in chemistry has 77 students, a loss of 11. The Law School with 167 students has 9 more students than last year. The Library School has 36 students, two more than last year, and the largest number that can be accommodated with the present facilities. The School of Music has a total of 418 students. The College of Engineering has 678 students, a loss of 50. This loss is largely in the present freshman class, which has 49 students less than that of last year. The Graduate School this year numbers 394, a gain of 17. The faculty of the university consists of 624 members, of whom 95 are full professors, 45 associate professors, 111 assistant professors, 21 special lecturers, 201 instructors and 152 assistants.

JOHN L. ULRICH, Ph.D. (Johns Hopkins University '13), has been appointed instructor in physiological psychology in the Catholic University of America.

DR. W. J. V. OSTERHOUT has been promoted to be professor of botany at Harvard University; Dr. P. W. Bridgman has been promoted to be assistant professor of physics.

DR. B. M. ALLEN, assistant professor of anatomy in the University of Wisconsin, has been chosen by the board of administration of the University of Kansas to be head of the department of zoology, succeeding Professor C. E. McClung, who a year ago became head of the department of zoology in the University of Pennsylvania. Promotions have been made as follows: F. H. Billings, from associate professor to professor of bacteriology; N. P. Sherwood, from instructor to assistant professor of bacteriology; W. H. Twenhofel, from assistant professor to associate professor of geology; T. T. Smith, from instructor to assistant professor of physics; R. K. Young, from instructor to assistant professor of physics and astronomy; W. J. Baumgartner, from assistant professor to associate professor of zoology; F. O. Dockeray, from instructor to assistant professor of psychology; H. W. Josselyn, from assistant professor to associate professor of education; H. A. Rice, from associate professor to professor of civil engineering; F. H. Sibley, from assistant professor to associate professor of mechanical engineering.

THE corporation of the Massachusetts Institute of Technology, at its meeting on June 6, confirmed the following promotions and appointments in the instructing staff of the institute: Dr. J. Arnold Rockwell appointed medical adviser in place of Dr. F. W. White. Associate Professor F. A. Laws, promoted to professor of electrical engineering. The following assistant professors are promoted to the grade of associate professor: Earle B. Phelps, research in chemical biology; S. P. Mulliken, organic chemical research; M. S. Sherrill, theoretical chemistry; G. E. Russell, civil engineering; Ervin Kenison, drawing and descriptive geometry; N. R. George and L. M. Passano, mathematics; M. deK. Thompson, electrochemistry; L. E. Moore, civil engineering. Two instructors were promoted to the grade of assistant professor: Edward Mueller, inorganic chemistry; J. W. Howard, topographical engineering. A number of assistants have been promoted to the grade of instructor, namely, N. S. Marston, electrical engineering; Duncan MacRae, inorganic chemistry, replacing C. R. Cressy; Dean Peabody, mechanical engineering; W. H. Wengert, mechanical engineering; W. J. Murray, analytical chemistry, replacing Mr. Fallon, and C. K. Reiman, inorganic chemistry. Assistant J. M. Livingston has been made research associate in applied chemistry. The following are new appointments to assistantships: Edward A. Ingham, biology; Robert D. Bonney, Warren E. Glancy, Leon W. Parsons and Charles S. Venable (half time), analytical chemistry, replacing E. T. Marceau, P. M. Tyler, C. K. Reiman (pro-

moted) and J. A. Gann, respectively; F. W. Lane and Philip B. Terry, organic chemistry, replacing W. J. Murray and J. W. Livingston, promoted; Arthur E. Bellis and Charles L. Burdick, theoretical chemistry, replacing B. F. Brann and Duncan MacRae, promoted; Lester F. Hoyt, water analysis, replacing W. J. Daniels; Francis H. Achard, Henry C. Harrison and Russell E. Leonard, electrical engineering, replacing D. M. Terwillinger, J. P. King and H. G. Jenks; Edgar W. Taft, military science, replacing A. J. Pastence; John P. Constable, naval architecture, replacing R. B. Pulsifer; Warren K. Green and William G. Horsch, physics, replacing Mr. Wells and Mr. Wilkins; Millard W. Merrill, electro-chemistry, replacing Mr. Gonzales; R. G. Daggett, research assistant in sanitary chemistry; George Richter and W. B. Van Arsdel, research assistants in applied chemistry; H. F. Thomson, assistant to the director of the research laboratory of electrical engineering and part-time instructor in electrical engineering; Robert E. Rogers, instructor in English; Thomas S. Holden, part-time instructor in mathematics; Clarence Hale Sutherland, instructor in civil engineering, replacing Mr. Bradbury, resigned; Ferdinand H. Pendleton, Jr., assistant in technical analysis, replacing Mr. Bishop.

DISCUSSION AND CORRESPONDENCE

THE CONSTITUENCY OF THE EXPERIMENT STATION

IN a communication to SCIENCE for May 9, page 708, Dr. Raymond Pearl, after stating that theoretically it is a primary function of the state experiment stations to conduct researches of a fundamental character which shall be calculated to discover basic natural laws, says:

> Actually, with a few rare and partial exceptions, experiment stations do nothing of the sort. On the contrary, what they do engage in is experimental work of a kind carefully calculated to make as strong an appeal as possible on the basis of its supposed "practicality" to the scientifically uneducated and uncritical farmers who make up its constituency. The experiment-station investigator in many cases (though happily not in all, as I am able personally to affirm after five years' experience in Maine) is compelled by force of circumstance over which he has no control to supplicate the great goddess truth with one ear closely applied to the ground in order that he may catch the first and faintest murmur of "what the public wants." If he has the temerity to venture upon a piece of research for which by the most extreme sophistry no evidence of immediate practicality can be adduced, he must do the work sub rosa and publish the results in such place that by no possible chance can the constituency ever learn of it.

It would be impossible to pack into the same space a greater amount of error and unwarranted sarcasm than is contained in these words. We are glad that Maine is so shining an exception to the general deplorable conditions herein set forth, and the state is to be congratulated upon its possession of so brilliant an exponent of what agricultural research ought to be. When, however, he writes in this sweeping fashion regarding the conditions surrounding some forty other stations in states covering a continent, many if not most of them some thousand or more miles away, it is not strange that in evolving the material largely from his inner consciousness, he has succeeded admirably in describing what the stations are not.

I write to discuss only a single sentence of this quotation and to resent its import in justice to a constituency not likely to answer for itself in these columns.

Dr. Pearl speaks of "the scientifically uneducated and uncritical farmers" as making up the constituency of the experiment stations and as constituting a real and natural bar to high-grade work. This is a sweeping and serious indictment against a series of federal institutions working in and supported by all the states of the union.

No special superiority is claimed for Illinois, but this occasion is taken to point out that of thirty-five farmers of the state serving on the advisory boards of our experiment station I happen to know of ten who are college graduates representing the following institutions: Dartmouth, Amherst, Yale, Illinois, Iowa and Cornell. How many of the

other members of these boards are college men I do not know, as this information is merely accidental, but they constitute a goodly company. It is the judgment and the criticism of these men that this station must first reckon with, and I have found them entirely competent to judge of the scientific reliability and soundness of our experiments as well as of their practical significance; nor is it necessary to publish sub rosa the better product of our laboratories.

These men are selected not by the station itself, but by the farmers' organizations of the state, and it is fair to assume that as time goes on the men nearest the station and its work will be college trained. In a few days this university will graduate nearly a hundred men from a four years' scientific course in agriculture. By the ratio of the past, fifty-five per cent. of these graduates will go at once to their farms, where, with even a larger number of men who have not fully completed the course and with a still larger number graduated from other colleges, they will constitute a rapidly increasing constituency trained not only in agriculture as a business, but in scientific methods of study. It is this class of men and the colleges which trained them that are in truth covered by what Dr. Pearl denominates as a scientifically uneducated and uncritical constituency.

In this state, and in others so far as my observation goes, since the station started a quarter of a century ago, the uneducated and uncritical farmers simply ignore the station and all it says. They do not count one way or the other in its policy, nor do they constitute or even characterize its constituency.

E. Davenport

University of Illinois

DOES A LOW-PROTEIN DIET PRODUCE RACIAL INFERIORITY?

To the Editor of Science: The argument usually advanced against the adoption of the "low-protein" diet plan is that the races practising it, when compared with those employing a protein-rich dietary, show in general some points of physical inferiority or lack energy, aggressiveness or courage. To this it has been replied that the diet is the result, rather than the cause, of such racial characteristics, but by the writers of most books on nutrition and related subjects, both scientific and sensational, this reply has been either overlooked or regarded as inadequate.

As there are no doubt many people who could be benefited by the adoption of a low-protein diet, judging from the results of the studies by Chittenden and others, but who hesitate to try it because of uncertainty as to its possible unfavorable effects, it would seem that the results of new investigations bearing upon the matter should be given wider publicity than their publication in the technical journals usually affords. Accordingly, the present note is offered to call attention to recent work which apparently tends to weaken the above argument in the cases of two of the countries often used as examples of its application, namely, Japan and India.

The disease called beri-beri, a multiple inflammation of the nerves, which is prevalent in most oriental countries, though also known among the fishermen of Newfoundland and Labrador, but which has been most extensively studied in Japan, long baffling explanation, has frequently been brought forward as evidence of the insufficiency of the low-protein diet. The cause of the disease has now been discovered, and found to have no relation to the deficiency of the diet in proteins in the usual sense. For some time it had been known that the use of unhulled grains instead of those from which the bran was completely removed would prevent the disease, and further, that the bran itself contained some principle which would cure many cases that had not progressed too far, but these facts, based chiefly on experiments on animals, were discounted by those who wished to uphold the protein theory.

Finally, however, three Japanese investigators[1] have succeeded in isolating from rice

[1] Suzuki, Shamimura and Odake, *Biochemische Zeitschrift*, XLIII., 89.

bran a nitrogenous base, which they call *oryzanine,* which proves to be a specific for the cure of the disease. Pigeons, chickens, mice and dogs, which would die in a few days or weeks with symptoms of starvation and nerve inflammation if fed on polished rice alone, remained in health when small amounts of oryzanine were added to the diet, as little as 0.3 gram per day being required for an average-sized dog. The bran of other grains and most vegetables were found to contain oryzanine, or at least a substance with similar therapeutic action, while milk, eggs, fish and meat showed little or none, although the alcoholic extract of fresh meat had some beneficial effects on dogs. The authors state that the experience of the Japanese in regulating the dietary of their navy, for instance, confirms in every way the results of these studies, in that beri-beri was stamped out only when foods rich in oryzanine were introduced, and feel justified in concluding that this substance is an absolute necessity for the maintenance of the health, not only of the lower animals, but also of the human race.

Many inferences might be drawn from these results. They show, for instance, the reason why graham bread is more desirable than white, which has been urged by diet reformers for many years, yet has been repeatedly questioned by scientists because no definite reason could be given and because actual experiment showed the white flour product to possess the greater digestibility. They suggest, indeed, that certain nervous troubles, which afflict the civilized races in general and the United States in particular, may have as at least a contributing cause the extensive use of grains from which the bran has been removed. But most interesting of all they show that the apparent inferior power of the Japanese and other eastern races to resist such diseases as beri-beri has nothing whatever to do with their low-protein diet as such, but is caused by their following the dictates of fashion and making use of bran-free, polished rice, as their staple article of diet.

The evident inferiority of the races inhabiting India, which enables a mere handful of British soldiers to keep them under control, is very often referred to as evidence of the inadequacy of the vegetarian—essentially low-protein—dietary made use of by these peoples, as a matter of religious observance. The recent survey by the Rockefeller Sanitary Commission has shown, however, that from 60 to 80 per cent. of the inhabitants of that country are infected with the hookworm. And as the degenerating influence of this parasite on both the physical and intellectual development of its victims is now so well known that further discussion of it is unnecessary, it would appear that we have herein sufficient explanation of the status of these races, without being obliged to assume that their diet is faulty.

With two of the supposedly most typical illustrations of the unfavorable results of a deficiency of protein in the dietary thus explained away, we are surely justified in inquiring, is there any evidence whatever that a low-protein diet ever causes or aids in the production of racial inferiority?

EDGAR T. WHERRY

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A RULING THAT IS AGAINST THE RULES

IN the "Opinions rendered by the International Commission on zoological nomenclature"[1] *Opinion 11* (p. 17) reads as follows:

> The "Table des genres avec l'indication de l'espèce qui leur sert de type" in Latreille's (1810) "considerations générales," should be accepted as designation of types of the genera in question (Art. 30).

The matter concerns the meaning of the word *type,* as used by Latreille. Some authors hold that Latreille could not have used it in the modern sense of *genotype,* simply because that particular meaning was entirely unknown at this time. This view surely is supported by common sense.

But admitting that there was cause for con-

[1] Smithsonian Inst. Publ. 1938, July, 1910.

tention, and that the case was not fully covered by the regular international rules on nomenclature, it is clear that it might be settled in one of two ways: either by making a special ruling with regard to it, or by inserting a paragraph in the general set of rules, which would cover it.

Both ways have been used: the first is the ruling given in opinion 11; the other is the second paragraph in Art. 30, II. (*g*), in the "International Rules of Zoological Nomenclature," as published in the Proceedings of the Seventh International Zoological Congress, 1912, p. 46. This says:

> The meaning of the expression "select the type" is to be rigidly construed. Mention of a species as an illustration or example of a genus does not constitute a selection of a type.

Every one familiar with the case knows that this paragraph was added to the rules with the special purpose of disposing of the doubt as to the meaning of Latreille's word *type*. At any rate, I know of no other case where it might be applied.

The two decisions are contrary to each other. The ruling made in opinion 11 accepts Latreille's "types" as genotypes in the modern sense. The paragraph under Art. 30, quoted above, forbids it to accept them as genotypes. For there is not the slightest question that Latreille meant the word *type* in the sense of illustration or example, for the other sense did not exist at that time. The argument (opinion 11, p. 18) that the use of the definite article (l'espèce) indicates that it was meant in the latter sense, is simply preposterous, since by substituting "une espèce" for "l'espèce" the sense of the sentence would not be changed at all.

It is much to be regretted that such an absurd situation has been created. Of course, this might be excused, since the opinion 11 was published two years ahead (in 1910), while the amendment to Art. 30 of the rules did not appear in print till 1912. Yet it might have been expected, for obvious reasons, that the latter should have been known to all members of the International Commission on nomenclature as early as 1907.

Of course the paragraph of the regular rules should prevail. But in order to remove all doubt in the minds of zoologists not familiar with the facts, and in order to avoid that the rulings of the commission might become a farce, one of the next "opinions" to be published should reverse opinion 11. But whether it is expressly repealed or not, opinion 11 can not stand any more, and zoologists not conforming to it should not be criticized for it.

A. E. Ortmann

Carnegie Museum,
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SCIENTIFIC BOOKS

The Omaha Tribe. By Alice C. Fletcher, holder of the Thaw fellowship, Peabody Museum, Harvard University, and Francis La Flesche, a member of the Omaha tribe. Twenty-seventh Annual Report of the Bureau of American Ethnology, 1905–06. Washington, Government Printing Office. 1911. Pp. 672, plates 65, Figs. 132.

The most obvious thing about this monograph is the authors' well-nigh complete neglect of the work of their predecessors. It is their avowed purpose (p. 30) to borrow nothing from other observers and to present "only original material gathered directly from the native people." Apart from any considerations of historical justice, this principle is unjustifiable from the standpoint of the student. A work so ambitious will naturally be regarded by almost every reader as definitive, as embodying everything that is known concerning the ancient life of the Omaha and as taking cognizance of all additional and contradictory testimony. In both hopes he will be disappointed. There are subjects on which other observers have collected information not furnished by Miss Fletcher and Mr. La Flesche. The parent-in-law taboo, for instance, is treated more fully in Say's notes[1] and in J. O. Dorsey's classical work[2] than in the brief

[1] In James's "Account of an Expedition from Pittsburgh to the Rocky Mountains" (London, 1823), I., pp. 232–234.

[2] "Omaha Sociology," Third Ann. Rept. Bur. Eth., pp. 262–263.

paragraph of the volume before us (p. 335). Say, indeed, furnishes admirably illustrative concrete data. Why should these be withheld from the reader? Even where no additional information is given by an older writer, it is often very important to know the earliest time at which the mere existence of some custom has been recorded. This is especially true of the Plains area where so much diffusion has demonstrably occurred. Yet the authors feel at liberty to ignore the fact that the office of "crow"-wearing policemen for the buffalo hunt was noted by Say[3] as early as 1820. Again, few subjects have aroused more interest among American ethnologists than age-societies and military organizations. J. O. Dorsey's data[4] on these are meager enough, but the authors have practically not a word on either.

The neglect of contradictory evidence gathered by others constitutes a still more serious defect, because the unwary reader thus obtains a one-sided, unduly simplified picture of the condition of affairs. According to Miss Fletcher and Mr. La Flesche, the Black Shoulder gens had two subgentes, one of which was still further subdivided. We get no suggestion that there was any conflict of opinion among their informants or that any change may have occurred in relatively recent times. Additional names, however, are given by J. O. Dorsey,[5] who carefully recounts the contradictory statements of his native authorities and hints at recent changes in the subgentes. With reference to two gentes the authors state that lesser groups within these units "have been mistaken for subgentes" (pp. 172, 178). Had notice been taken of J. O. Dorsey's data, it would be possible to understand what may be meant by these words. As it is, we may assume with some plausibility that the phrase is a covert criticism of J. O. Dorsey, for that writer undoubtedly does speak of "subgentes" where his successors find only "groups." However, a reference to Dorsey's text[6] and to the authors' definition of a "subgens" reduces the criticism to a verbal misunderstanding. Miss Fletcher and Mr. La Flesche (p. 137) understand by "subgens" a section of the gens that has a distinctive rite, while a "subdivision" or "group" has none, though it had a particular office in the rite belonging to the gens. Dorsey does not understand by "subgens" anything of the kind. He tells us that in his opinion two of his main informants always mean a classification for marriage purposes when they speak of divisions of a gens, and it is clear that this feature is uppermost in his own mind whenever he uses the term "subgens." If the authors' criticism is meant as an innuendo against Dorsey, it is not only disingenuous but incorrect.

It is very interesting to examine the solitary instance of open criticism directed by the authors against their great predecessor. They write (p. 589, footnote):

> The statement has been made (11th Ann. Rep. Bur. Ethnol., 542), "In two of the buffalo gentes of the Omaha (the Iñke-sabĕ and Hañga) there is a belief that the spirits of deceased members of those gentes return to the buffaloes" and the buffalo is spoken of as "the eponymic ancestor." The writer here cited fell into the error of regarding the animal which furnished the peculiar symbol in the rites of these kinship groups as the progenitor of the members of the groups. No such confusion seems to have existed in the Omaha mind. Men were not believed to be descended from animals. If the expressions "Buffalo people," "Elk people," "Deer people" or "Thunder people" were used, these descriptive terms were not employed in a literal sense but as tropes.

A little farther (p. 601) we read a still more categorical denial:

> Although, according to the Omaha view, man is so closely connected with the animals, he was not born of them; no trace has been found showing any confusion or mixture of forms; no Omaha believes that his ancestors were elk, or buffalo, or deer, or turtle, any more than that they were the wind, the thunder or the sky.

This criticism, whatever be its merits, is

[3] *Op. cit.*, p. 189.

[4] *Op. cit.*, pp. 342, 352.

[5] *Ibid.*, pp. 230–231.

[6] *Op. cit.*, pp. 242, 245, 258.

dishonest in selecting for its point of departure an incidental statement in a work not specially devoted to the Omaha, instead of taking the fuller accounts in the "Omaha Sociology."[7] In this paper there is given the translation of the words employed in addressing a dying Iñke-sabe, and these words certainly imply a belief that the person addressed is going to rejoin his ancestors, the buffalo. On the same page Dorsey also cites a legend in which the Iñke-sabe are said to have been at one time buffalo. If Dorsey's critics wish to say that he has mistranslated his informant's words, they should so state. If they wish to say that he has sucked his information out of his thumbs, they should so state. If they wish to say that his informants did not represent the consensus of Omaha opinion, they should so state. They should state further that Dorsey himself does not hesitate to tell us that the legend was unknown to two of his best informants. Dorsey was ahead of his generation and of some of the succeeding generation in not suppressing data that might interfere with the smoothness of his tale.

"The Omaha Tribe" must, however, be considered primarily as a field report. Judged from this point of view, it will be found wanting in several respects. In the first place, the tremendous wealth of concrete material is classified according to canons of aboriginal rather than of scientific logic. Thus, the Medicine Pipe ceremony is described under the heading of Music, apparently because its native name means "to sing for some one." Data on agriculture and hunting are assembled with those on the ritual of the maize and the ceremonial hunt. "Social Life" is made to include not only such legitimate topics as kinship terms, courtship and marriage, and etiquette, but also cooking and foods, dressing and tanning skins, quill work, weaving, personal adornment and clothing.

Secondly, there are large fields of ethnological interest that the authors either do not touch at all or treat in a very unsatisfactory manner. Foremost among these is mythology and folklore. Inconsistent as such a supposition is with the authors' general attitude, we are tempted to assume that their failure to enter into these subjects is an expression of their admiration for the thoroughness with which J. O. Dorsey has accomplished the task that was to be done in this field.[8] Unfortunately the reader does not profit by this exhibition of tacit generosity. For all he could learn from Miss Fletcher and Mr. La Flesche, there has never been published any systematic collection of Omaha tales. Moreover, the fact that a splendid collection exists does not absolve monographers of a tribe from the duty of briefly characterizing the native mythology with reference to both substance and form and of showing its relations to other mythologies. The few paragraphs devoted to this matter in the volume before us (pp. 600, 601, 608) can not be regarded as even a serious attempt in this direction.

Another very remarkable deficiency appears in the discussion of material culture and art. The fact that these subjects are treated with disproportionate brevity is a venial fault, for there are few monographs in which all phases of culture are treated with uniform thoroughness, and some allowances must be made for individual interests. But every professional ethnologist may reasonably be expected to pay some attention to points that have come to be of theoretical interest to his fellow-students. Many questions of this sort relating to the material culture of the Plains Indians have been indicated by Dr. Wissler,[9] but very few of them are elucidated by the authors. We do not learn anything of the form of the travois mentioned on page 275; the description of the cradle-board (p. 327) is too vague for comparative purposes; no opinion is expressed as to the antiquity of the men's shirt among the Omaha (p. 355). As the distribution of painted and embroidered patterns has been diligently studied among the Plains Indians for at least ten years, and as Kroeber

[7] *L. c.*, pp. 229, 233.

[8] "The Ųegiha Language," Contributions to North American Ethnology, Vol. VI.

[9] "Material Culture of the Blackfoot Indians," Anthrop. Papers Amer. Mus. Nat. Hist., Vol. V., Pt. 1.

and Wissler have attempted to characterize the art of several Plains tribes, the failure of the authors to furnish the data necessary for classifying the Omaha with reference to their decorative designs is even more surprising.

The subjects that have particularly appealed to the authors are sociology and ceremonial life. The chapter on Tribal Government constitutes a real contribution, giving a clear outline of the several grades of chiefs, the council of seven chiefs and the modes of election. The discussion of the Sacred Pole is also a creditable performance, though it adds rather details than anything fundamental to our previous knowledge. The analogies pointed out by J. O. Dorsey between the Hedewatci and the Sun Dance stand confirmed by the new evidence (p. 253). Unfortunately, in these chapters, as elsewhere, there appears the tendency, now definitely abandoned by ethnologists, of attaching historical value to the origin accounts of a primitive tribe, in spite of their naïvely rationalistic psychology. Though the authors seem to regard the establishment of the chiefs' council as "a development of earlier forms rather than an invention or arbitrary arrangement of the 'old men'" (p. 207), other passages clearly reveal the antiquated view just criticized. In the section on Tribal Organization (p. 134 ff.) we are actually asked to believe that the dual division of Omaha society was but the reflection of a mythological conception! This whole section adds very little to our comprehension of the subject. The specific marriage-regulating functions of the subgentes, touched upon but not clearly expounded by Dorsey, remain unilluminated. What is more important, the authors have not logically correlated their own data. We are told that the gens was exogamous (pp. 195, 325); that the subgens or subdivision of a gens was exogamous (p. 137); that there was a tradition as to the exogamous character of the two grand divisions and that "of the marriages in existence among the Omaha twenty-five years ago, a good majority represented the union between members of gentes belonging to the two rather than to one of these grand divisions" (p. 135). Do not the authors recognize the fact that if a gens is exogamous, any smaller group within the gens *must* be exogamous; that if an association of five gentes is exogamous, any one of the gentes *must* be exogamous? The problem is to determine which social group is primarily, and which derivatively, exogamous. This it may not be possible to do at present, but it is at least desirable that professional ethnologists should see the problem.

The terms of relationship (pp. 315–17) are not presented in a satisfactory way, though it is true that the subject is an exceedingly difficult one. Here, where the entire psychological interest lies in the native point of view, the authors take for their starting-point the *English* classification of kin. The consequence is great clumsiness of arrangement and useless repetition of terms. Moreover, some interesting meanings of native terms given by Say are omitted in the present list.

By far the most valuable addition to our knowledge is to be found in the chapter on Societies (pp. 459–581), of which two classes are distinguished—the social and the secret societies. The former include the Hethushka (Grass Dance) organization, membership in which was dependent on the reception of public war honors. Our attention is called to the fact that, while the dance has spread over a wide area, only the Omaha observe the religious rites of the opening ceremony. Another (chiefs') society is said to have been the only one "in which headgear that approximated the character of a mask was used" (p. 481). It would be interesting to know whether these headgears resembled those worn by two officers of the Mandan Bull society,[10] in which the face was covered and eyeslits were provided. According to Dorsey,[11] mere buffalo-skin caps, with the horns standing up and the buffalo hair hanging down below the wearer's chest, were worn by four members of another Omaha organization, the Buffalo Dancers. It is curious that in mentioning the Tokalo (Tukala) performance neither Miss Fletcher

[10] Maximilian Prinz zu Wied, "Reise in das innere Nord-America," II., p. 142.

[11] *Op. cit.*, p. 348.

nor Dorsey should have recognized the name as the Dakota term for "fox" or "kit-fox."

Most of the secret societies were entered by virtue of a dream or vision, those having received a revelation from some particular supernatural power being united in the same organization. This does not, however, apply to the Shell society, into which persons were admitted by unanimous consent of the members. All the offices in the last-mentioned society were obtained by purchase; in the other organizations this element, which plays so important a part among several of the Plains tribes, does not seem to be pronounced. Societies composed exclusively of women have not been found among the Omaha (p. 459), but women were evidently prominent in the Shell society, and tradition states that in early times its principal leader was a woman (p. 516). The Shell and the Pebble societies perform shamanistic practises, of which a "shooting" ceremony common to both recalls the Midewiwin of the Central Algonkian, and the authors incline to the opinion that the two societies are historically related. From the fact that the Pebble rituals deal with "more fundamental conceptions" than the origin myth of the Shell society they infer that, granting the relationship, the Pebble society is the older of the two (p. 529). Indeed, there is evidence that at least one of the elements of the Shell performance, the use of a swan wing, has been borrowed from the Pebble society (p. 519); and the description of the "shell" as a round stone in one of the ritualistic songs (p. 529) is interpreted by the authors as pointing in the same direction. Nevertheless, it is quite possible for one society to have borrowed special features from another without being necessarily of later origin in the totality of its traits. As for the relatively more fundamental character of the Pebble society, the authors do not explain what may be their criterion of greater antiquity or primitiveness. One thing is clear: the comparison of the ritual of one organization with the origin myth of another is unjustifiable, though consistent with the authors' belief that the Shell society was founded upon the myth accounting for its origin (p. 516). Such a view has become less and less tenable as proof has accumulated in different areas that ritual is primary and ritualistic myth secondary.

While the evidence for the greater antiquity of the Pebble society is thus inconclusive, the authors' opinion on the historical connection between the Pebble and Shell organizations seems to me correct. It has been challenged by Radin,[13] but apparently on the basis of a single loose and misleading statement by the authors, viz.,

> As these two societies are the only ones in the tribe which observe shamanistic practises and as they both strongly emphasize magic, it is not impossible that at one time they may have been connected (p. 581).

Radin quite properly objects that the observance of shamanistic tricks is too general a phenomenon to warrant the conclusion and that it is unnecessary to assume any historical connection "unless this has been shown to be the case." The authors certainly should have defined what they meant by "shamanistic," but it seems clear that they do not use the term in the accepted sense but with some specific connotation. For to nearly every one of their secret societies they ascribe what others might call "shamanistic practises," yet these are said to be confined to the two societies under discussion. The authors have obviously arrived at their view because common to both societies are several specific features, such as organization by lodges and the shooting ceremony. These features are not found in the Bear and Buffalo and Ghost societies; they are, therefore, not generally phenomena of Omaha life, and their double occurrence is not explained as a mere reflection of Omaha modes of thought. Whatever may be the origin of other elements of the two ceremonial complexes, the traits mentioned have had, in all probability, a common origin.

The foregoing paragraphs have pointed out with sufficient clearness the character of Miss Fletcher and Mr. La Flesche's book. The au-

[13] "The Ritual of the Winnebago Medicine Dance," *Journal of American Folk-Lore*, XXIV. (1911), p. 191.

thors have placed us under obligation by adding a considerable number of facts to our knowledge of the Omaha, notably on the subject of societies. They have not accomplished the task of giving us a definitive study of Omaha ethnology. We feel grateful for the new data presented by them, but we are also very grateful for the fact that they have had for their predecessor so sane, conscientious and competent an ethnographer as the late Rev. J. O. Dorsey.

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AMERICAN MUSEUM OF NATURAL HISTORY

BOTANICAL NOTES

NOTES ON RECENT BOOKS AND PAMPHLETS

GEORGE F. ZIMMER'S "Popular Dictionary of Botanical Names and Terms" (Dutton) is intended mainly for botanists, horticulturists and others who have to deal much with plant names. The little book of 122 pages is a little different from the usual type of botanical dictionaries, more attention being given to the meanings of specific names, and this will commend it to many students who are somewhat deficient in their knowledge of Latin. For those it would have been well to have at least indicated the accent for each name.

The little books brought out by Dr. Gustav Lindau, of Berlin, under the general title of "Kryptogamenflora für Anfänger" promise to furnish models which might well be followed by American makers of similar books. Already three books have appeared, namely: "Die höheren Pilze"; "Die mikroskopischen Pilze"; and "Die Laubmoose." Bound in substantial cloth, and containing about 250 pages, these books commend themselves to us as admirably adapted for their purpose—namely, that of helping beginners in the systematic botany of the lower plants.

Bergen and Caldwell's "Practical Botany" (Ginn) aims to relate the study of plants in the secondary schools to everyday life more "than is usually done." Accordingly the book is distinctly of the informational rather than the scientific type, and for this reason will appeal to many principals and boards of education. The present reviewer is not in sympathy with the notion that science must always be related to "everyday life" (whatever that may imply), but he finds much to commend in the book. The authors know the science, and pedagogics so well that they have made a useful book, whose faults are due to the underlying theory rather than to any shortcomings on their part. This theory is accountable for the chapters on Timber, Forestry, Plant Breeding, Plant Industries, Weeds, which contain much that is certainly interesting, but that is just as certainly *not botany*. It would be much better for the botanists to allow these applications and extensions of botany to be taken up by foresters, agronomists, horticulturists, agriculturists, etc., a task for which they are entirely competent. We should respect the boundary lines between a science and its applications.

Winkler's "Botanisches Hilfsbuch" (Hinstorff) gives interesting data regarding about twelve hundred plants (mainly tropical) that have economic value. Although primarily designed for tropical planters, merchants, officials and explorers, it will be found to be a useful book in every botanical library.

The Dudley Memorial Volume published by Stanford University contains papers, appreciations and contributions in memory of the late Professor William R. Dudley who died June 4, 1911. In addition to the memorial addresses and papers and lists of Professor Dudley's pupils (covering 32 pages), the volume includes eight scientific papers. The first of these—"The Vitality of the *Sequoia gigantea*"—was prepared by Professor Dudley himself. The others are "The Morphology and Systematic Position of *Calycularia radiculosa*," by D. H. Campbell; "Studies of Irritability in Plants," by G. J. Peirce; "The Gymnosperms growing on the Grounds of Stanford University," by LeRoy Abrams; "The Synchytria in the Vicinity of Stanford University," by James McMurphy; "The Law of Geminate Species," by D. S. Jordan; "Some Relations between Salt Plants and Salt Spots," by W. A. Cannon; "North American

Species of the Genus *Amygdalus*," by W. F. Wight. The volume constitutes a fitting tribute to the botanist whose life it commemorates.

Burman's "Flora of Manitoba," which was printed two years ago, contains in a small 30-page pamphlet a general discussion of the vegetation of the province of Manitoba followed by a list of the species of flowering plants and ferns. It is the only available guide to the plants of that part of Canada.

Stone's "List of Plants Growing without Cultivation in Franklin, Hampshire and Hampden Counties, Massachusetts" (1913), reminds one of the previous classical lists by Hitchcock and Tuckerman which appeared many years ago under similar titles, and dealing with the flora of the Connecticut Valley. It contains 1,493 species of ferns and flowering plants, 1,190 of which are native, the remaining 303 being naturalized.

Meier's "School and Home Gardens," while dealing with plants, is not botanical, though of interest to many botanists. It is designed primarily to help in the commendable effort to interest children in the planting of seeds and the growing of such plants as may be grown in the windows of school buildings or out of doors, under ordinary care. It can be commended most heartily.

Allied to the last is E. Benjamin Andrews's "The Call of the Land" (Judd) dealing largely with out-of-doors, and the things that grow there. While not botanical, it breathes of flowers, and grasses and growing crops, and of the shrubs and trees that make for comfort and beauty and happiness. It is a book distinctly worth while.

A recent number of the *Missouri Botanical Garden Bulletin* includes descriptions of the laboratories in the garden, accompanied by four half-tone plates from photographs. Accompanying the descriptions is a general discussion containing many suggestive sentences, as "Botanical laboratories are the workshops of those who study plants scientifically." "It is to be remembered that the important botanical gardens of the world are educational institutions." "In the broadest sense these laboratories must represent the possibility of using apparatus and chemicals, books and herbarium specimens, live material from garden or field, and cultures of microscopic organisms."

A recent circular (113) of the Bureau of Plant Industry contains a suggestive paper on soil bacteriology, by K. F. Kellerman, in which he shows that it is "a subject of almost bewildering complexity, but very intimately associated with the normal physiology of all crop plants." In a later circular (120) the same author has a short paper on nodule-forming bacteria (*Bacillus radicicola*) which should be helpful to those attempting to inoculate the soil with these organisms.

Recent numbers of the *Botanical Magazine* (Tokyo) contain Makino's "Observations on the Flora of Japan," Matsuda's "List of Plants Collected in Hang-chou" (both in English), and Koidzuma's "Morphology, Systematik and Phytogeography of Cupuliferæ" (in Japanese), with other shorter articles.

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SPECIAL ARTICLES

PRELIMINARY NOTE ON THE RELATIVE PREVALENCE OF PYCNOSPORES AND ASCOSPORES OF THE CHESTNUT-BLIGHT FUNGUS DURING THE WINTER[1]

IN studying the dissemination of the chestnut-blight fungus during the past winter the writers obtained some results that showed that, contrary to the generally accepted opinion, pycnospores are produced in enormous numbers and washed down the diseased trees during every winter rain.

The production of pycnospores was tested by what we have termed pycnospore traps. A part of the rainwater flowing over a canker was conducted down a glass slide and through a mass of absorbent cotton. After each rain the cotton of the traps was brought to the laboratory and a quantitative determination

[1] Investigations conducted in cooperation with Office of Forest Pathology, U. S. Department of Agriculture.

made of the number of viable spores of the blight fungus which were retained by each trap. Traps were set at six different locations at West Chester, Pa., and analyses have been made after each rain period for the months of January to April, inclusive.

There were seven rain periods in January with precipitation varying from 0.13 to 0.88 inch. The number of viable pycnospores obtained from each trap varied from 55,000 to 61,255,000 for each analysis. During February there were four rain periods with precipitation varying from 0.07 to 0.78 inch. After each rain the number of viable pycnospores obtained from each trap varied from a few thousand to 92,000,000. Similar results have been obtained for the months of March and April.

The cotton for the traps was transported to the laboratory in sterile Petri dishes and the number of viable spores determined by the poured plate method, using 3 per cent. dextrose agar, plus 10.

One of the noteworthy facts is that ascospores do not appear to be washed down the tree during the winter rains, although they are present in abundance in the pustules. That all the colonies appearing in the poured plates made from the cotton traps came from pycnospores was demonstrated in two different ways: first, by their time of appearance; second, by the absence of ascospores in the centrifuged sediment as determined by microscopic examination.

The effectiveness of the cotton traps in retaining the spores washed down has also been determined by cultures. In many cases only about two per cent. of the spores passing into the cotton was retained. This being true, the figures given above are but a meager expression of the enormous numbers of pycnospores produced. Considering the fact that we have also demonstrated that pycnospores can be subjected to freezing temperatures for considerable periods without losing their vitality, they must play a very important part in the dissemination of the blight fungus.

The forcible expulsion of the ascospores of the blight fungus has been reported by Rankin[1] and Anderson[2] and the influence of moisture upon this phenomenon has been demonstrated by both writers. They have not, however, taken temperature conditions into account. The expulsion of ascospores depends not only upon the presence of sufficient moisture, but also upon the temperature to which the lesion has been subjected. The influence of temperature upon the expulsion of ascospores has been determined during the past winter by means of laboratory and field tests. Laboratory tests have shown that bark bearing perithecial pustules, if subjected to low temperatures (42 to 46° F.) for a period would not begin the expulsion of ascospores until exposed to favorable temperatures for three or four days, even though supplied with an abundance of moisture. The minimum temperatures at which spore expulsion takes place vary from 52 to 60° F.

On November 26, 1912, a large number of ascospore traps (49) were placed upon lesions of the blight fungus in a badly diseased coppice growth at West Chester, Pa. These have been under continuous observation since that time and accurate rainfall and temperature records kept at that station. There was practically no expulsion of ascospores until March 21, although there had been many rain periods (21) with precipitation varying from 0.01 to 1.64 inch. The above records show that ascospores were not washed down from the lesions during any of the winter rains and that there was practically no expulsion of ascospores during the period from November 26 to March 21.

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A STRIKING CORRELATION IN THE PEACH

THE importance of correlations in the characters of plants from the standpoint of either research or practise is so well known as to

[1] Rankin, W. H., Report Penna. Chestnut Blight Conference, p. 46, 1912. *Phytopathology*, 3: 73, 1913.

[2] Anderson, P. J., *Phytopathology*, 3: 68, 1913.

need no setting forth. The search for them is one of the imperatives with those who experiment or those who cultivate plants and once begun becomes fascinating—indeed irresistible. The seeker is so seldom rewarded—correlations are not common phenomena—that haste may be pardoned in publishing a discovery.

This spring a most striking correlation in the peach, which seems not to have been noted before, came to the attention of the writer. In the work of describing the flowers of a considerable number of varieties of peaches, Mr. Charles Tubergen, of the horticultural department of this station, found that there was a somewhat remarkable difference in the color of the inside of the calyx cups of different varieties. In some of the blossoms the color of the inner surface of the cup was green, usually a light green but varying somewhat in different varieties. In other varieties the cellular tissue of the inner part of the cup was a deep orange in color—not the surface alone but the tissue to the depth of several layers of cells was orange. In no other part of the calyx, the blossom, or the plant, in the spring of the year, does there appear to be a similar color.

Upon investigation it was found that the flowers having the green cup were those of the white-fleshed varieties while the blossoms with the orange cup were those of the yellow-fleshed ones. We were able to observe the character in two trees each of 307 varieties of peaches and of 47 varieties of nectarines. Of the peaches 145 varieties were white in flesh and green inside the calyx-cup; 162 were yellow in flesh and orange inside the calyx-cup. In the nectarines white and green were correlated in 36 and yellow and orange in 11 varieties.

In neither peach nor nectarine are there intermediates in color of calyx-cup or in flesh of fruit. The parentage of a sufficient number of the varieties examined is known to make it certain that green calyx-cup with white flesh and orange calyx-cup with yellow flesh are each inherited as one in cross-breds.

What is the explanation of this hidden connection between colors in two organs of the peach which are not only quite distinct but which appear on the plant in periods as widely separated as blooming-time and fruiting-time? The correlations are so constant and their hereditary behavior is such as to suggest that each is a single color character diffused through the flesh of the peach fruit and the inner tissue of the calyx cup. Surely the two organs in which the correlation appears are morphologic units but the capacity to produce the same color, differing probably only in degree in the parts in which it is found, and at widely different times, must be conceived to be a physiologic unit. If so, why localized in these two organs and not generalized throughout similar tissue in other parts of the plant as correlated colors generally are?

This correlation has some practical value in peach-breeding, since it will often enable the breeder to tell a year or two sooner than he otherwise could what color of flesh his peach will have since the first blossoms seldom set fruit; it is of material value in classifying peaches—adding another very constant taxonomic character; through its uses for the breeder and the systematist it becomes ultimately of considerable value to peach-growers. Lastly, it seems to the writer to have value in throwing light on current conceptions of morphologic and physiologic units in plants and also presents a problem to be explained as to why there is a localization of a particular color in two quite distinct organs.

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MICHIGAN ACADEMY OF SCIENCE

The Michigan Academy of Science held its nineteenth annual meeting at Ann Arbor on April 2, 3 and 4.

The following is the program as given at the meeting. The numbers marked with a star will be published in the Fifteenth Annual Report of the Michigan Academy of Science.

*"The Porcupine Gold Deposits of Ontario," Mr. R. E. Hore.

SECTION OF SANITARY AND MEDICAL SCIENCE

Thursday, April 3

*"Ferments," Dr. J. G. Cumming.

*"A Bacterial Disease of the Larva of the June Bug (*Lachnosterna* sp.)," Miss Zae Northrup.

"Duration of Tr. Gambiense Infection in Rats and Guinea-pigs," J. F. Morgan.

*"The Environment of Soil Bacteria," Dr. F. H. Hesselink van Suchtelen.

*"The Influence of *Bacterium Lactis Acidi* on the Changes caused in Milk by some of the Common Milk Microorganisms," C. W. Brown.

"The Use of Chlorinated Lime for the Disinfection of Drinking Water," Dr. M. L. Holm and E. R. Chambers.

*"Ozone as a Means of Water Purification," R. W. Pryer.

"Toxic Bases in the Urine of Parathyroidectomized Dogs," W. F. Koch.

"Serum Tests in the Diagnosis of Infectious Abortion of Cattle," Dr. E. T. Hallman.

"The Increase of Hog Cholera Virus by Intraperitoneal Injections of Salt Solution," W. S. Robbins.

"Studies in Avian Tuberculosis," L. R. Himmelberger.

"The Sensitizing Group in the Protein Molecule," Dr. V. C. Vaughan.

"Immunization against Tr. Brucei with Cultures," Dr. F. G. Novy.

"Determination of Minimum Lethal Dose of Tr. Brucei," C. A. Behrens.

"Cultivation of Spirilla," P. H. de Kruif.

*"Secret Remedies, Nostrums and Fakes," Dr. W. S. Hubbard.

SECTION OF ECONOMICS

Thursday and Friday, April 3 and 4

"The London Dock Strike of 1912," Carl E. Parry, of the University of Michigan. Discussion opened by W. H. Hamilton, of the University of Michigan.

*"Farm Organization as a Factor in Rural Economics," Wilbur O. Hedrick, of Michigan Agricultural College. Discussion opened by Edward D. Jones, of the University of Michigan.

"The Sphere of Pecuniary Valuation," C. H. Cooley, of the University of Michigan. Discussion opened by Frank T. Carlton, of Albion College.

*"Psychological Antithesis of Socialism," H. A. Miller, of Olivet College.

GENERAL PROGRAM

Presidential address, by Professor E. C. Case: "The Geological History of Michigan."

Reports on the work of the Michigan Geological and Biological Survey, by R. C. Allen, director, and A. G. Ruthven, chief naturalist.

Papers on Eugenics

"Eugenics," Professor Victor C. Vaughan, department of medicine, University of Michigan.

"The Biological Aspect of Eugenics," Professor A. Franklin Shull, department of zoology, University of Michigan.

Public address, "Travels in Mexico," by Professor Charles J. Chamberlain, department of botany, University of Chicago.

The Research Club of the University of Michigan gave a smoker to the members of the academy in the rooms of the University Club, Memorial Building.

SECTION OF GEOLOGY AND GEOGRAPHY

Thursday, April 3

*"Origin of Continental Forms, IV.," Dr. Howard B. Baker.

*"Studies in Structure and Stratigraphy in the Saginaw Valley in Relation to Occurrences of Oil and Gas," Mr. R. A. Smith.

"Climatic Variation in Permian Times as recorded in Red Beds of Texas," Professor E. C. Case.

"The Discovery of Illinoian Till in the Detroit River Region," Professor W. H. Sherzer.

"The History of Lake Erie in Post-Glacial Time," Mr. Frank B. Taylor.

"Further Studies on the Variation of the Angle of the Optic Axes, with Temperature," Professor E. H. Kraus.

"Vanadiferous Pyroxenes from Libby, Montana," Professor W. F. Hunt.

"Some Pro-Glacial Lake Shore Lines of the Bellevue Quadrangle, Ohio," Professor Frank Carney.

"Some Problems in Stratigraphy and Correlation of the Pre-Cambrian Rocks of Michigan," Mr. R. C. Allen.

(*a*) "Results of Leveling along the Algonquin Beach in the Northern Peninsula in 1912," (*b*) "Order of Development of Glacial Lakes in the Great Lakes Region," (*c*) "Centers of Dispersion and Probable Extent of the Kansan and Pre-Kansan Drifts," Mr. Frank Leverett.

"The Chemical Composition of Bornite," Professor E. H. Kraus and Mr. J. P. Goldsberry.

"The Teaching of Economics in the High School." Discussion opened by J. E. Mitchell, of Alma College, and F. M. Taylor, of the University of Michigan.

*"The Taxation of Local Public Utilities in Michigan," E. H. Ryder, of Michigan Agricultural College.

"Public Utility Accounting in Michigan," David Friday, of the University of Michigan. Discussion opened by H. C. Adams, of the University of Michigan.

SECTION OF ZOOLOGY

Thursday, April 3

"Factors Governing Local Distribution of the Thysanoptera," A. F. Shull.

"Results of the Mershon Expedition to the Charity Islands, Lake Huron Coleoptera," A. W. Andrews.

"Types of Learning in Animals," J. F. Shepard.

"The Lepidoptera of the Douglas Lake Region, Cheboygan County, Michigan," Paul S. Welch.

"Check-list of Michigan Lepidoptera. II. Sphingidæ (Hawk Moths)," W. W. Newcomb.

*"On the Breeding Habits of the Log Perch," Jacob Reighard.

"A List of the Fish of Douglas Lake, Cheboygan County, Mich., with Notes on their Ecological Relations," Jacob Reighard.

"May the Remains of Adult Lepidoptera be Identified in the Stomach Contents of Birds?" F. C. Gates.

"The Mitochondria," R. W. Hegner.

"The Unione Fauna of the Great Lakes," Bryant Walker.

"Notes on the Genus *Edaphosaurus* Cope," E. C. Case.

"Methods of Preparing Teleost Embryos for Class Use" (demonstrations), B. G. Smith.

*"An Adult *Diemyctylus* with Bifurcated Tail," B. G. Smith.

"Notes on the Mollusks of Kalamazoo County, Mich.," Harold Cummins.

*"Sarcoptid Mites in the Cat," Harold Cummins.

*"The Origin of Continental Forms, III.," Howard Baker.

"An Ecological Study of the Birds of Manchester, Mich.," F. Gaige.

"Notes on Crustacea Recently Acquired by the Museum of Natural History of the University of Michigan," A. S. Pearse.

"Distribution of Multiple Embryos on the Blastoderm," O. C. Glaser.

*"Nesting of Our Wild Birds," Jefferson Butler.

*"The Factors that Determine the Distribution of *Boleosoma nigrum* in Douglas Lake, Cheboygan County, Mich.," H. V. Heimburger.

"Structure of the Olfactory Organs," E. W. Roberts.

"A Method of Producing Cell-like Structures by Artificial Means," E. W. Roberts.

"Some Notes on Rhizopods from Michigan," E. W. Roberts.

"An Interesting Form of Protozoa," E. W. Roberts.

*"Oxygen and Carbonic Acid Contents of Douglas Lake, Cheboygan County, Mich.," D. A. Tucker.

"Some Observations on *Asplanchna amphora*," D. A. Tucker.

"Some Effects of Sunlight on the Starfish," H. M. MacCurdy.

"Some Abnormalities Observed in Proteocephalid Cestodes," G. LaRue.

"Note on a Cestode Found in a Garter Snake," G. LaRue.

*"Some Observations on Intestinal Villi," O. M. Cope.

"Some Physiological Changes in the Lamprey Egg after Fertilization," P. Okkelberg.

"A Collection of Fish from Houghton County, Mich.," T. L. Hankinson.

"The Lagoons and Ponds of Douglas Lake, Cheboygan County, Mich.," H. B. Baker.

"The Shiras Expeditions to Whitefish Point, Mich.": (1) "Birds," N. A. Wood. (2) "Mammals," N. A. Wood. (3) "Amphibians and Reptiles," Crystal Thompson and Helen Thompson.

"Notes on the Ornithology of Clay and Palo Alto Counties, Iowa," A. D. Tinker.

"A Check-list of Michigan Mammals," N. A. Wood.

"The Variations in the Number of Vertebræ and Ventral Scutes in the Genus *Cegina*," Crystal Thompson.

"An Artificially Produced Increase in the Proportion of Male Producers in *Hydatina senta*," A. F. Shull.

SECTION OF BOTANY

Thursday, April 3

"Biometric Studies in Oaks" (with lantern), Carl Oberlin.

"Biometric Studies in Oaks" (with lantern), J. H. Ehlers.

*"The Origin of *Capsella arachnoidea*" (with lantern), Henri Hus.

*"The Antitoxic Action of Chloral Hydrate upon Copper Sulphate for Pea Seedlings," R. P. Hibbard.

*"Improved Methods for the Quantitative Determination of Dilute Solutions of Electrolytes," R. P. Hibbard.

"Effect of Illumination on the Twining of Plants," F. C. Newcombe.

"Conditions for the Diageotropism of *Asparagus plumosus*," Margaretta Packard.

"A Heteroprophic Mycorhiza" (with lantern), Walter B. McDougall.

*"Some Notes on the Black Knot of Plums," J. A. McClintock.

"Some Further Observations on *Sclerotinia*," J. B. Pollock.

"A Sand-binding Fungus," J. B. Pollock.

"The Relic Dunes of Little Point Sable" (with lantern), W. E. Praeger.

*"The Pine Hills at Lowell, Mich." (with lantern), Bert E. Quick.

"Plants observed on Mackinac Island in 1912," C. K. Dodge.

*"The Flora of Parkdale Farm, Rochester, Mich.," O. A. Farwell.

"The Early Extent of Prairies in Southern Michigan," H. A. Gleason.

*"Notes on a Few Plants from the Vicinity of Ann Arbor," H. A. Gleason.

*"Car-window Notes on the Vegetation of the Upper Peninsula," R. M. Harper. Read by H. A. Gleason.

*"Permanent Vegetation Quadrats at Douglas Lake," Ada K. Dietz.

*"Rôle of Vegetation of a Mill Pond" (with lantern), F. A. Loew.

*"Key to the Species and Varieties of *Solidago*, in Michigan," C. H. Otis.

*"An Easy Formula for Obtaining Alcohols of any Strength," Richard de Zeeuw.

"Lipolytic Action in a Rust," G. H. Coons.

"Soft Rot of the Hyacinth," G. H. Coons.

Richard de Zeeuw,
Secretary

East Lansing, Mich.

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

The eighty-ninth regular meeting of the Botanical Society of Washington was held in Assembly Hall of the Cosmos Club, at 8 P.M., Tuesday, May 6, 1913, with twenty-four members and two guests present.

The following papers were presented:

The Effect of the Recent Freeze in California (with lantern): Dr. David Griffiths.

Dr. Griffiths discussed the effect of the January freeze on vegetation of the southwest, with special reference to California. The main regions where tropical and subtropical things are being grown were visited. He showed 40 slides made from negatives taken in February and March, showing injuries to citrus fruits, avocados, cherimoyas, mangoes, carobs, acacias, olives, eucalyptus, etc.

While the temperatures were unusually low, there are indications that they have been lower in the remote past. That such cold spells of weather are very infrequent is proved by the fact that such natives as *Rhus laurina*, eriogonums and other natives in California, and the giant *Cereus, cholla, Celtis, Olneya*, etc., in southern Arizona, are severely injured. Many introduced trees which have attained a diameter of three feet have been killed outright.

Injuries were very severe throughout all of the citrus regions, but even where the temperatures went to 10–17° F. in general throughout a region, an occasional orchard situated upon an abrupt elevation above the general plain escaped with even unfrozen fruit. Owing to differences in elevation, air-drainage and exposures, conditions are exceedingly varied and present some of the most important problems in connection with the relation of climatic conditions to crop development. At no time in the present generation has there been such an opportunity to determine the adaptability of the scores of introduced plants of the Pacific Coast region. Through some of the various agencies operating in agricultural lines a careful survey should be made the present season to systematize and place on record the results of a condition which, although of infrequent occurrence, is nevertheless of the utmost scientific and economic import.

The Method of Types Applied to the Nickernut: Mr. H. C. Skeels.

Mr. Skeels called attention to the last sentence of division (*e*) under Canon 15 of the American Code of Botanical Nomenclature, which reads as follows: "The genera of Linnæus's Species Plantarum (1753) are to be typified through the citations given in his Genera Plantarum (1754)." Under this clause the following genera were mentioned:

Genus	Type Species	Now Referred to
Alpinia	*A. racemosa*	*Renealmia*
Cerbera	*C. ahouaj*	*Thevetia*
Cratægus	*C. aria*	*Sorbus*
Cucurbita	*C. lagenaria*	*Lagenaria*
Glycine	*G. apios*	*Apios*
Hibiscus	*H. malvaviscus*	*Malvaviscus*
Jatropha	*J. manihot*	*Manihot*
Medicago	*M. radiata*	*Trigonella*

Applying the method of types to the nickernut, Mr. Skeels called attention to Mr. Trimen's identifications of the Flora Zeylanica specimens which are published in Vol. 24 of *The Journal of the Linnean Society, Botany*. On the basis of these identifications, Mr. Skeels concluded as follows:

"In conclusion, going back to our three original species, the 'Catti kitsjil' of the East Indies, the *Cæsalpinia nuga* (L.) Aiton of the floras, under the method of types of the American Code, becomes *Cæsalpinia crista* L., the type being Fl. Zeyl. 157. The common gray-seeded nickernut, generally known as *Cæsalpinia* or *Guilandina bonducella*, becomes *Guilandina bonduc* L., the type being Fl. Zeyl. 156. And the yellow-seeded, large-leafletted nickernut, generally known as *Guilandina bonduc*, becomes *Guilandina major* (DC.) Small, being based through De Candolle, on *Guilandina bonduc* L. Species Plantarum, ed. 2."

What would be the Effect of the Arctic Night on Tropical or Subtropical Vegetation? Dr. F. H. Knowlton.

Dr. Knowlton called attention to the ancient floras of the North Polar region. Many of the fossil plants found there are of a tropical or subtropical character. No satisfactory explanation of the relation of such plants to the conditions of light and darkness supposed to have prevailed has been found. Dr. Knowlton asked for suggestions from the members of the society and a brief discussion followed.

C. L. Shear,
Corresponding Secretary

PHILOSOPHICAL SOCIETY, UNIVERSITY OF VIRGINIA
MATHEMATICAL AND SCIENTIFIC SECTION

The eighth regular meeting of the session of 1912–13 of the Mathematical and Scientific Section was held May 19.

Professor R. M. Bird read a paper by himself and Mr. W. S. Calcott on "Some Studies of Chemical Reactions, which may be Connected with the Constant Association of Vanadium Sulphide with Sulphur-bearing Petrols and Asphalts."

Mr. Justus M. Cline presented a paper by himself and Professor Thos. L. Watson on "The Drainage Changes in the Shenandoah Valley Region in Virginia."

Professor Thos. L. Watson read a paper entitled "A Meteoric Iron from Paulding County, Georgia."

Professor Chas. N. Wunder read a paper on "A Photometric Survey of the Stars of the Huygenian Region of the Great Nebula of Orion."

Professor W. H. Echols read by title a paper "On the Expansion of a Function in Terms of Rational Functions." This paper will be read at the regular meeting in October.

Wm. A. Kepner,
Secretary

University of Virginia

SCIENCE CLUB OF THE UNIVERSITY OF WISCONSIN

At the 125th regular meeting of the club, held April 17, 1913, Dr. A. S. Loevenhart, of the department of pharmacology of the University of Wisconsin, presented a paper on "The Relation of Oxidative Processes in the Central Nervous System to Stimulation and Depression."

The observed effects of asphyxia are, in the order of occurrence, stimulation, depression, paralysis, death. By using carbon monoxide, hydrocyanic acid and other drugs that inhibit the oxygen-carrying power of the blood without interfering with the elimination of carbon dioxide, and by reducing the time of the experiment so much that no accumulation of acid products is possible, it is found that decrease of oxidation *per se* is responsible for the initial stimulation observed in asphyxia.

Increased oxidation, secured by the use of certain derivatives of iodbenzoic acid, results in suspension of respiration and other evidences of depression of the central nervous system.

Anesthesia is a case of secondary depression resulting from decreased oxidation as opposed to depression from increased oxidation, which is probably the condition occurring in sleep. A "safe" anesthetic is therefore an impossibility, since the function of an anesthetic is to hold bodily oxidation down in the region of depression between stimulation and death.

The lecture was illustrated with a number of diagrams from automatic recording apparatus, and some pieces of apparatus that had been specially designed or improved in connection with the investigation.

Eric R. Miller,
Secretary

SCIENCE

Friday, June 20, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

LIVINGSTONE AS AN EXPLORER[1]

David Livingstone, it is scarcely necessary to remind you, was of Highland descent, his grandfather having been a crofter on the little island of Ulva, off the west coast of the larger island, Mull. In appearance he showed clearly that the predominant strain in his ancestry was what we call Iberian for want of a more definite word. That is to say, that he was of that very old racial strain still existing in western Scotland, western Ireland, Wales and Cornwall, which has apparently some kinship in origin with the peoples of the Mediterranean, and especially of Spain and Portugal. Indeed, according to such descriptions as we have of him, and such portraits as illustrate his appearance, he was not unlike a Spaniard, especially in youth and early middle age. His height scarcely reached to 5 feet 7 inches, his hair and moustache, until they were whitened with premature old age, were black, his eyes hazel, his complexion much tanned by the African sun, but at all times inclining to sallow. He possessed a natural dignity of aspect, however, which never failed to make the requisite impressions on Africans and Europeans alike. Bubbling over with sly humor, with world-wide sympathies, and entirely free from any narrowness of outlook, he possessed a very strong measure of self-respect, coupled with a quiet, intense obstinacy of purpose.

. . . .

[1] From the address to commemorate the centenary of the birth of Livingstone given before the Royal Geographical Society, London, and the Royal Scottish Geographical Society and printed in the journals of these societies.

Let us briefly consider his achievements as a geographical discover. He directly inspired the search for Lake Ngami, and was the main agent in carrying South African exploration beyond the arid plateaus of Bechuanaland and the Kalahari desert into what is really the Zambezi basin. Oswell and Murray contributed to the cost of his journeys, but he by his influence found the guides and secured the friendship or the neutrality of the native chiefs. He acted as interpreter-in-chief, and, thanks to the mastery he had acquired over the Sechuana language, was able to converse fully and freely with the natives of South-Central Africa. He also picked up a considerable knowledge of other dialects. He served diligently and skilfully as physician and surgeon all who were connected with these journeys. But his own predilections were for botany, zoology and the study of man. It was the impression that native reports of his character had made on Sebituane, the Makololo conqueror of the upper Zambezi, and the resultant protection afforded, which made it so easy for Livingstone and Oswell to reach the Chobe River and the upper Zambezi in 1851.

Between 1852 and 1856, Livingstone traced the main course of the Zambezi from its confluence with the Chobe northwards to near the sources of the Liba, and from this point westwards he was the first scientific geographer to lay down correctly the position of the upper Kasai and Kwango affluents of the Congo.

Livingstone may be quoted as the discoverer of the great Kasai (perhaps the principal among the Congo affluents for volume and for extent of drainage area). At first it would seem probable that the Pombeiros, at the beginning of the nineteenth century, must have crossed the Kasai in order to reach the court of the Mwata Yanvo. But they appear to have deflected their route southwards, after leaving the upper Kwango, so that they pass round the sources of the Kasai, leaving them to the north. Ladislaus Magyar, the Hungarian explorer and trader (who married a negress of Bihé and traveled over Angola between 1849 and 1864), penetrated about 1851 to the upper Kwango and the northwest limits of the Zambezi basin, and may have seen the infant Kasai in 1855, a few months before or after Livingstone passed by. But he did not communicate the information to the world until after Livingstone's journey, and never, I think, specifically mentioned the Kasai, at any rate, before the publication of Livingstone's book. Moreover, he was no trained geographer or taker of observations for fixing points of latitude and longitude. Silva Porto, a Portuguese trader of Bihé, reached the upper Zambezi and South Congoland in the fifties and sixties, but his wanderings resulted in no additions to the map of Africa.

It is, indeed, remarkable what Livingstone's predecessors missed rather than what they found. Dr. Lacerda reached to little Lake Mofwe, an isolated lagoon about 20 miles south of Mweru and a short distance east of the Luapula. Yet apparently neither he nor any member of his expedition, before or after his death, had the curiosity to penetrate northwards one day's journey and discover Lake Mweru, or visit the banks of the Luapula. Going through the Bisa country they heard of a lake—"Lake Chuia," or Shuia, a short distance to the westward, and knew that the Chambezi flowed into it. This was Livingstone's Bangweulu (named, as he tells us, from one of its islands). But the Portuguese of Lacerda's mission, like those of the Monteiro-Gamitto expedition of 1831–32, made no effort to locate Bangweulu and place it definitely on the map. Lake Nyasa was

heard of (as "Nyanja") by the Portuguese of the eighteenth century and early nineteenth; but it was not till 1846 that its waters—so far as historical records go—were actually seen by a Portuguese (Candido de Costa Cardoso). Gasparo de Bocarro passed near to Lake Nyasa in 1616 on his way to Kilwa and Mombasa, but seems to have crossed Lake Malombe or the upper Shiré only, and not actually to have seen Lake Nyasa.

Returning from Angola to the Chobe River, he discovered the Victoria falls, and followed the Zambezi more or less closely down to its delta, emerging on the seacoast at Quelimane.

On his second Zambezi expedition he revealed to the world Lake Nyasa, Lake Chilwa (miswritten Shirwa), the high mountains of the Shiré region, and the course of the Shiré River, the Luangwa River to the west of Lake Nyasa, most of the northern confluents of the Zambezi in their lower courses, and the Butonga highlands. This second expedition was also the means of effecting a great increase in our knowledge of the Zambezi delta.

On his third great African journey he renewed previous explorations in the direction of the Ruvuma, and traced a good deal of the course of that East African river. He was practically the first European to explore West Nyasaland and the northern Bemba or Awemba country; he discovered the south end of Tanganyika, and made a shrewd guess at its outlet through the Rukuga (which river he styled the Longumba). He first revealed the great Mweru swamp or Chisera. ["Elephants, buffaloes and zebras grazed in large numbers on the long sloping banks of a river or marsh called Chisera." This considerable extent of alternate swamps or shallow water was afterwards rediscovered by Sir Alfred Sharpe.] Livingstone made known to us lakes Mweru and Bangweulu and the connecting Luapula River, and the course of the great Lualaba or upper Congo at Nyangwe. He also recorded the existence of the upper Lualaba or Kamolondo. He was the first European to penetrate as far north as S. lat. 3° 30′ near the Elila River, and describe the Manyuema forests with the large chimpanzis and pygmy elephants found in them. He mentions for the first time the Lomami River, and is the first explorer to hear of the country of Katanga, its mineral wealth and its—as yet—unexplored, inhabited caverns of vast size.

> A month to the westward of Kazembe's country lies Katanga, where the people smelt copper ore (malachite) into large ingots shaped like the capital letter I, weighing from fifty to a hundred pounds. The natives draw the copper into wire for armlets and leglets. Gold is also found at Katanga.

Livingstone was the first writer to mention the possible existence of Lake Kivu; of Kavirondo gulf (Victoria Nyanza); and of Lake Naivasha: from Arab information, of course.

He was the first to record the existence of drilled stones in the country to the southwest of Tanganyika, which seemed to be evidence of the existence of a people of ancient Bushmen culture in that direction, and his remarks generally on the Stone Age in Africa, on the possible existence of undiscovered ancient types of mammals and of mammalian fossils, all show an enlightenment in speculative scientific imagination greatly in advance of his times. He was also in all probability the first writer since the Portuguese chroniclers of the sixteenth century to allude to the remarkable ruins of stone-built forts, villages and cities in southeast Africa. He derived his information from natives, and perhaps also from Boer hunters. He also mentions the coins found in excavating the shore of

Zanzibar Island, with Kufic inscriptions, and perhaps dating back to the ninth or tenth century A.D. (Sir John Kirk confirms this statement, and adds that some of these coins were of Harun-ar-rashid's reign, and bore the name of his viziers, Yahya or Fadl.)

His biblical studies drew him into Egyptology, and one of his incentives to the exploration of the Nile sources was the conviction that Moses when living in Egypt had taken a great interest in Nile exploration. Livingstone half hoped that in discovering the ultimate sources of the Nile he might come across archeological traces of Egyptian influence. He was not pursuing in this direction an absolute chimera.

The physical appearance of so many of the Bantu tribes between Lunda, on the southwest, and Manyuema, Bambare and Buguha, on the northeast, constantly suggested to Livingstone's mind the idea of an immigration of Egyptians into Central Africa. Had he lived to penetrate to the countries north of Tanganyika to see the Hima or Tusi aristocracy on the highlands of equatorial Africa, he would have been still more convinced of the ancient inflow of Egyptian influence into these regions: though it is a theory which it is very unsafe to pursue on the scanty evidence we possess at the present time.

When traveling from Tanganyika to Mweru in 1869, he remarks on the appearance of the chief and people of Itawa.

> Nsama, the chief, was an old man with head and face like those sculptured on the Assyrian monuments. . . . His people were particularly handsome, many of the Itawa men with as beautiful heads as one could find in an assembly of Europeans. Their bodies were well shaped, with small hands and feet—none of the West Coast ugliness—no prognathous jaws or lark heels.

There is another entry in his journal derived from Arab information which bears on this theory of the Hamitic permeation of Negro Africa.

> The royal house of Merere of the Basango [northeast Nyasaland] is said to have been founded by a light-colored [Hamitic?] adventurer, who arrived in the country with six companions of the same race. Their descendants for a long time had straight noses, pale skins and long hairs.

His journeys into southern Congoland threw a very interesting light on a native kingdom made famous by the earlier Portuguese explorations—that of the Kazembe of Lunda, whose capital was between lakes Mweru and Bangweulu.

In the early seventeenth century a great negro empire had arisen in southern Congoland, partly due, no doubt, to the arms and trade goods derived from the Portuguese, but partly also to the after-effects of the Sudanese civilization of Central Congoland under the Bushongo dynasty. This empire of Lunda ruled over all the south of Congoland and a small part of northern Zambezia.

In the early eighteenth century a member of the family of the Lunda emperor, or "Mwata Yanvo," moved to the south of Lake Mweru and founded a feudatory kingdom there. He received the title of Kazembe or "lieutenant."

Kazembe's capital was by the side of a little lake called Mofwe. Livingstone approached it along a path as broad as a carriage road one mile long, the chief's residence being enclosed by a wall of reeds 8 or 9 feet high and 300 yards square. The innermost gateway was decorated by about sixty human skulls, and had a cannon, dressed in gaudy colors, placed under a shed before it. This, no doubt, was a gift from the Portuguese. Kazembe himself had a heavy, uninteresting countenance, without beard or whiskers, somewhat of the Chinese type, his eyes with an outward squint. He smiled but once during the day, yet that was pleasant enough, though

the cropped ears of his courtiers and the human skulls at the gate made Livingstone indisposed to look on him with favor. Kazembe was usually attended by his executioner, who wore a broad Lunda sword under his arm, and a scissor-like instrument at his neck for cropping ears. This was the punishment inflicted on all who incurred the Kazembe's displeasure.

Kazembe sat before his hut on a square seat placed on lion and leopard skins.

> He was clothed in white Manchester print and a red baize petticoat so as to look like a crinoline put on wrong side foremost. His arms, legs and head were covered with ornaments, and a cap made of various-colored beads in neat patterns. A crown of yellow feathers surmounted his cap. His head men came forward, shaded by a huge ill-made umbrella and followed by dependents. . . .

This Central African monarch (whose descendant was finally deposed for cruelties by the British government) bore an evil reputation; yet he was a good friend to Livingstone and put no obstacle in his path; though he politely told him that lakes and rivers only consisted of water, and that to ascertain this fact by ocular inspection would not repay him for his fatigues and outlay in trade goods!

Livingstone from boyhood had taken a great interest in botany and in the appearance of trees and flowers in the landscape. His observant glance led him to note all the more salient features of the African flora from the Cape to the equatorial forests of Manyuema. His books are full of little word-pictures of the strange, stately or beautiful trees and plants he encounters. He records in his journal the spectacle of the Crinum "lilies" of the Luangwa valley, which in the first rains "flower so profusely that they almost mask the rich, dark, red color of the loamy soil, and form a covering of pure white where the land has been cleared by the hoe." The weird stone- or pebble-like Mesembryanthemums of the Kalahari Desert, and the gouty, leafless geraniums and vividly colored pumpkins and gourds of the same region arrest his attention; the Bauhinia bushes with their golden or bluish tinted, bifid leaves, and the scale insects on them exuding a sweet manna; the noble giraffe-acacia trees, the euphorbias of very diverse modes of growth, the *Strophanthus* creepers whose seeds possess medicinal or violently poisonous qualities, the borassus and hyphæne fan-palms, the wild date, and the "noble raphias," the pandanus and dracænas of the Zambezi delta or of inner Congoland, the innumerable forest trees of northern Zambezia and southern Congoland: all are illustrated in his pages by well-chosen words and sometimes explanatory drawings; and most are correctly named, in contrast with the very unscientific nomenclature of the generality of travelers in his day.

Livingstone notices as he descends the slopes of the mountains towards the Chambezi the abundance of the fig-tree which yields the bark-cloth, so that the natives cared little for the cotton cloths of Europe and India. He also in this region observed green mushrooms, which, on being peeled, revealed a pink fleshy inside (the *Visimba* of the natives). Only one or two of these mushrooms were put into a wooden mortar to flavor other and much larger kinds, the whole being pounded up into a savory mess, which was then cooked and eaten. But in Livingstone's experience this mushroom diet "only produced dreams of the by-gone days, so that the saliva ran from the mouth in these dreams and wetted the pillow." The country on the Chambezi slope of these Muchinga mountains was devoid of game, the game having been killed out by far-reaching and long-continued drives through the hopo fences into pitfalls.

He crossed Tanganyika to resume his

search for the Lualaba in July, 1869. In his journal he recorded the abundance of pandanus screw pines off the west coast of that lake. As he traveled through the Guha and Manyuema countries he entered "the land of gray parrots with red tails" ["to play with gray parrots was the great amusement of the Manyuema people"]. The Manyuema country he describes as "surprisingly beautiful, palms crowning the highest heights of the mountains, and climbers of cable size in great numbers hanging among the gigantic trees." Strange birds and monkeys were everywhere to be seen. The women went innocently naked; and the Adams of this Eden wore nothing but a small piece of bark cloth. Both sexes atoned for their absence of clothing by having their bodies tattoed with full moons, stars, crocodiles, "and devices recalling Egyptian hieroglyphics." Yet although their country—prior to the Arab raids—seemed an earthly paradise, small-pox came every three or four years to Manyuemaland and killed many of the people.

It was in the Manyuema country that he came into contact with the large chimpanzi (*Troglodytes schweinfurthi*) of eastern equatorial Africa, whose range extends from the Welle-Mubangi River and Unyoro to the eastern bend of the upper Congo and the west coast of Tanganyika.

The soko, as he called this large chimpanzi, always tried to bite off the ends of the fingers and toes of the men with whom it fought, not otherwise doing them any harm. It made nests, which Livingstone described as poor contrivances with no architectural skill.

The Manyuema told him, however, that the flesh of the soko was delicious; and Livingstone thinks that through devouring this ape they may have been led into cannibalism. The sokos gave tongue like foxhounds; this was their nearest approach to speech. They also laughed when in play, and in their relations with the natives were quite as often playful as ill-tempered. The lion, which seemingly existed in the Manyuema country in spite of the forest, was said to attack and kill the soko, but never to eat him. The sokos lived in monogamous communities of about ten. Intruders from other camps were beaten off with fists and loud yells. If one tried to seize the female of another, the remainder of the party united to box and bite him. The male often carried his child, relieving the mother occasionally of her burden.

Rhinoceroses were shot in the Manyuema country. He also alludes to the pygmy elephant of Congoland, "a small variety, only 5 feet 8 inches high at the withers, yet with tusks 6 feet 8 inches in length"; and notes the killing of an elephant with three tusks, one of them growing out through the base of the trunk. [The pygmy elephant (*Elephas africanus pumilus*) of the equatorial Kamerun-Congo forests, was only rediscovered in the early part of the twentieth century.]

Livingstone was almost an expert in geology and petrology. He felt the keenest interest in the records of the rocks, and fully realized the importance of paleobotany. When descending the valley of the Central Zambezi in 1856 he discovered fossil remains of *Araucaria*, or of conifers now confined to South America and Australasia; and fully realized what his discovery meant in regard to ancient land connections between South Africa, India and South America. He was much impressed with the probable coal-bearing strata of sandstone throughout the Ruvuma Valley. A great many pieces or blocks of silicified wood appeared on the surface of the soil at the bottom of the slope up the plateaus. He wrote:

This in Africa is a sure indication of the presence of coal beneath.

In the sands of some of the rivers pieces of coal were quite common. He originated the theory of the rift valley of Lake Nyasa.

It looks as though a sudden rent had been made so as to form the lake and tilt all these rocks nearly over [namely, in the direction of Ruvuma].

His observations would seem to show that the level of Lake Nyasa was once about 55 feet above its present high-water mark. It is possible that at this high level its overflow of waters first of all passed into the basin of Lake Chilwa, and then flowed northwards into the Ruvuma system.

. . . . . .

Stanley, by relieving him when he did, gave him at least two more years of life, a certain measure of happiness, and the sweet consolation that he was not forgotten, and that the magnitude of his discoveries was appreciated. In this brief sunset glow of his life he turned his face once more towards Lake Bangweulu in order to trace the course of the Luapula to Mweru, and its junction with the Lualaba, half hoping that he might then travel down the broad stream till he entered the Bahr-al-Ghazal or the Albert Nyanza; but, although he now possessed comforts he had long lacked, and faithful, comparatively disciplined men, his strength gave out under constant exposure to rain, and to soakings in crossing rivers and marshes. Severe hemorrhage set in from the bowels, and he died of exhaustion at Chitambo's village in the swamps near the south shore of Bangweulu on May 1, 1873.

This brief record of his achievements and his sufferings may fitly close with an extract from his last journals, showing that he died a martyr to that form of religion which we call science:

In this journey I have endeavored to follow with unswerving fidelity the line of duty. . . . All the hardship, hunger and toil were met with the full conviction that I was right in persevering to make a complete work of the exploration of the sources of the Nile.

Harry H. Johnston

LECTURE AND RECITATION METHODS IN UNIVERSITY INSTRUCTION

A reference to the systems of instruction in Germany, Canada and the United States will most readily bring out the relative value of the lecture and recitation methods in university instruction. In the German and many of the Canadian universities the popular method of giving instruction consists in delivering a series of lectures and following these by a rigid final examination, while in the United States the daily recitation of text-book assignments is much more common than in the former countries. In Canada the term lecturer is frequently applied to a regular member of the faculty, but in the United States it is seldom heard except when applied to a temporary member of the university staff, who has been engaged to give a course of lectures on some special subject, and a college professor is more frequently regarded as a teacher than as a lecturer.

A student, therefore, who has been familiar with the German system or who has spent some time in certain departments of the Canadian universities, and then enters almost any of the American institutions of higher learning, will be impressed by the difference in the methods of instruction in these various countries. He has been familiar with the freedom of the lecture system where he is in a large measure placed on his own responsibility and, as a rule, may attend lectures or not as he chooses. Under this system he is inclined to feel that the professor has no concern regarding his success or failure beyond the duty of providing him with the intellectual substance of the lecture course in the best form and exacting a pound of flesh on the final examination. This notion is, as a rule, due to the lack of intimate contact between the in-

structor and the students because lecture classes are frequently very large. It is also often erroneous because the student is surprised to find later how familiar a discerning lecturer has become with his characteristics, from seeing him day after day in the lecture hall.

The fact that the student feels free during the year to follow his own desires, but at the same time knows that the responsibility for his conduct falls upon his own shoulders, has much in its favor for most students, although it is detrimental to some. In the better class of students it develops a certain independence of action and thought which better fits them for the responsibilities they must assume after leaving college, while in the students who are weak morally it often cultivates undesirable habits which lead to excesses. In Germany, where the university students are left almost entirely to themselves during the first two years of their academic life, the results of absence of restraint are expressed in the large amount of social immorality which is said to exist among German students. No doubt this freedom in college life is largely responsible for the conditions which led Bismarck to say that one third of the German students are never heard of, one third "gehen zum Teufel" and the other third rule Germany.

An objection to the lecture-examination system which is frequently raised, is that too much stress is laid on the final examination. It is said that good students often do not do themselves justice because of undue mental and physical strain and that the work is neglected until the last few weeks or months of the term, then crammed up for the final examination and immediately forgotten. It is no doubt true that most students can make a much better showing on daily recitations than when called upon to discuss a whole term's work, but, after all, the test which tries out a man for the larger spheres of his future life, is not that of holding enough matter in his mind to recite one day's assignment, but rather at the end of a term, or year to be able to sum up and round out the whole season's work. The greater benefits derived from a college course consist not in the abundance of details remembered from the text-books—because that is necessarily small—but rather in the inspiration for achievement and the capacity for work which a man develops by studying under enthusiastic and capable instructors. In preparing for the final examinations, during the last few weeks or months of the year, the student cultivates the ability to do the greatest amount of work in the least possible time, and a man now connected with a large commercial firm in Chicago once remarked to the writer that the best training for his future business career which he ever received was in preparing for the severe final examinations in one of the universities where the lecture-examination system is used.

There are certain features in the lecture system which are of advantage in the development of the instructor. To lecture properly a professor must have his subject well in hand, and, on the whole, he requires a much broader grasp of it than he who teaches from a text-book. While only few men make first-class teachers, I believe there are many men who might pass as teachers who would be complete failures at lecturing. A lecturer, as a rule, aims to eliminate all material not essential to the proper exposition of his subject, and when the subject is properly presented the student carrying a heavy course absorbs and remembers the outstanding features of the subject without having them obliterated by a great mass of unnecessary text-book details. It may be said that when the material is thus presented the student neglects collateral reading and the charge may be made that students educated under the lecture system are deficient in this line of study because the lectures usually contain the information demanded by the examination papers. If the lecture course is properly conducted, however, it is easier to require collateral reading than when a text-book is used, because the student may become familiar with the text assigned, but it is difficult to persuade him to go beyond its covers.

While the lecture system is employed in many of the universities and colleges of the United States the daily recitation of assigned

exercises is the more popular system of teaching. This system has factors in its favor as well as some objections. The reason why this system is more popular in this country is, no doubt, due primarily to the democratic nature of all institutions. There is a tendency to bring the instructors in the classroom nearer to the students and to do away with the aloofness in which English or German professors hold their students, and while this has certain advantages it also often has disadvantages in lowering the faculty from a dignified position in the eyes of the students. Along with this condition there exists a popular sentiment that many students should be graduated from the state institutions whether they wish to go through college or not. It is not at all to be inferred from this statement that all these state institutions have low standards of scholarship, but rather that a student who is continually coached along by an instructor will finally graduate who never would graduate if left to his own resources. It is believed, however, that a rigid examination system would cull out a lot of these men and that a lower percentage of mentally poor students would graduate under such a system. Another reason suggested for the popularity of the recitation method in this country is the fact that many of the students entering college are younger and less mature, from an academic standpoint, than in some other countries and they therefore require more personal assistance from their instructors. The greatest factor in favor of the recitation method—and there are those who regard this of sufficient importance to offset all objections—is that if a teacher be at all efficient even a slow student must get a fairly clear idea of the subject studied. On the other hand, the recitation is liable to degenerate in colleges to a grade-school-system of instruction. Where daily recitations are required the student who recites satisfactorily is quite justified in demanding that the results of these responses play an important part in the calculation of his credits and the result is that many instructors spend too much of their time grading the students instead of giving them the fundamentals of the subject. If the professor requires recitations on an assigned exercise he must demand that every student respond to a satisfactory degree, because a student's failure to recite for several successive periods has a demoralizing influence on the class as a whole. The professor is therefore obliged to resort to some means of forcing an inefficient student to prepare his work, and in many institutions rash criticisms or severe sarcasm are employed even in dealing with mature postgraduate students. Influences of this sort tend to lower the dignity of the faculty, and, as a rule, little is gained, because a man who will not do his best in college, at least after he has passed his first year, is seldom of much use after he leaves the institution. If he be doing his best nothing more should be expected of him; the results of his work reflect upon himself. The system of questioning students is being carried to such an extreme in this country that text-books are sometimes issued which contain the interrogatives, "why" and "how," inserted in the body of the text, thus taking away from the instructor the credit for having enough ability and initiative to ask necessary questions and develop the subject as a teacher with any enthusiasm or knowledge of the subject might wish to develop it. Fortunately such texts are designed chiefly for use in the grade schools.

In conclusion it may be said, as a result of observations in the different countries mentioned, that the chief objections which can be made to the lecture and rigid examination system are that it is hard on the weak student and gives the profligate too much freedom. As a rule it cultivates a greater independence of action and at the same time places the faculty in a more dignified position in the eyes of the students. It is the best system for imparting a broad knowledge and promoting enthusiasm for a subject.

The recitation of assigned text-book exercises assists the student who is mentally weak, as he can thus get a clearer grasp of the subject. This method is the most desirable for teaching subjects in which reference is made to a large amount of technical details, and it

is no doubt better for the average student during his first year in college, since his actions may be more carefully observed by the members of the faculty.

To offset the tendency of many young students who are away from home for the first time, to be led astray by the freedom and glamor of college life, some American colleges and universities have adopted the Freshman Adviser system. With this scheme the freshmen are divided into groups and each group assigned to some member of the faculty, preferably an instructor of experience, who acts as a counsellor and adviser to the students in his charge. If the paternal interest be wisely exercised many students may be started right in college life and succeed where otherwise they would fail, and the system becomes a great help to students and faculty. There is often a tendency, however, in the smaller institutions, for the advisers to pamper the students and make them as dependent as they would be in a preparatory school. The writer would, therefore, recommend this system, in a properly restricted form, as an excellent addition to the administration of a college or university in which the freedom of a lecture system permits the ignorant and immature student, away from guardianship for the first time, to develop bad habits which lead to undesirable excesses and a careless attitude towards his academic duties.

E. S. Moore

THE KAHN FOUNDATION

"The Kahn Foundation for the Foreign Travel of American Teachers" has issued Vol. I., Nos. 1 and 2, of its "Reports." The benefaction is unique enough to be interesting, and broad enough to invite debate, if not criticism. The deed of gift, dated January 6, 1911, was executed by Mr. Albert Kahn, of Paris, who had already founded *bourses de voyage* in France, Germany, Japan and England, and who contemplated similar action in Russia, China "and elsewhere." The trustees are Mr. Edward D. Adams, of New York City, or a successor to be nominated by the founder or by his personal representatives; the President of Columbia University; the President of the American Museum of Natural History; the President of Harvard University; the Secretary of the Smithsonian Institution; or their respective successors. The purpose, which seems to be somewhat indefinite, is stated as follows:

> For each year . . . the trustees shall in their discretion select two or more American teachers, scholars or investigators . . . preferably from the professors of such American colleges or universities as the trustees may from time to time designate . . . who will enter into and appreciate the spirit of the foundation and look upon their travels as preparation for the performance of high duties in the instruction and education of the youth of their country, and not as affording a mere vacation or pleasure trip. . . . The founder suggests that the itinerary of such travelers shall be regulated by the trustees in their discretion and shall, if deemed practicable, involve an absence from America of at least one year and include the various countries of Europe and Egypt, India, China, Japan, Ceylon and Java. The founder further suggests that each recipient of a "bourse de voyage" shall agree to furnish to the trustees a report containing the impressions and results of his travels, which report shall not exceed fifty printed pages. The reports of these travelers may be published by the trustees . . . or by the founder, in Paris, at his own expense.

The benefaction amounts at present to $3,000, and four fellows have been appointed. In 1911–12, the beneficiaries were Dr. Francis Daniels, professor of Romance languages in Wabash College, and Dr. J. H. T. McPherson, professor of history and political science in the University of Georgia; for 1912–13 they are Dr. William E. Kellicott, professor of biology in Goucher College, and Dr. Ivan M. Linforth, assistant professor of Greek in the University of California. The "Reports" before us are those of Drs. Daniels and McPherson. Dr. Daniels carried out the letter of the deed, going *via* Great Britain, Europe and Egypt to the Orient, visiting Ceylon, India, the Malay Peninsula, Hong Kong, China and Japan, returning thence to San Francisco. Dr. McPherson confined himself to Europe, with the purpose of acquaint-

ing himself with the methods and *status* of instruction in his own field, and of informing himself on "the progress of public opinion in regard to international arbitration." The report of Dr. Daniels is a most interesting series of "reactions" to the endless succession of scenes and people that passed before him. It is notable for its tart remarks on the Germans, for its complimentary references to the English, and for its conclusions, which run thus:

> Three facts particularly struck me in my journey through the Orient. The first is the political and industrial might of Great Britain. . . . The second fact is that the Asiatics are more highly civilized than one dreams of before making the journey. . . . The third fact is the supremacy of American influence in China and Japan.

Dr. McPherson devotes more attention to educational affairs, but, like Dr. Daniels, has some hard words for the Germans. He found Paris the most profitable place he visited, and he says:

> If I shall ever be so fortunate as to have a year to devote to historical study abroad, I shall prefer Paris to either Berlin or Oxford.

More to the point, perhaps, is his final question.

> And now it is only fair to face the question, what assurance can I give the trustees that as a consequence of my year abroad the purposes of the trust and of the founder are to be promoted?

He interprets these purposes as two—"to promote the cause of civilization by rendering the beneficiaries better qualified for . . . their high duties . . . and to further international comity by helping to dispel provincial prejudice and ignorance." In other words, he infers that research is no principal object of the Kahn Foundation. In this he is probably right. For the arc of travel contemplated by the founder would appear to place the residence necessary for investigation out of the question. On the other hand, American college professors, as a class, are so accustomed to European travel in any case, that there would not seem to be much need for fresh stimulus in this direction. It might be suggested, therefore, that, if the foundation is to fill a distinct niche, the objective should be to enable American teachers to acquaint themselves with the Orient. The undoubted influence of the United States upon Japan in the past, and her growing influence in China today, to say nothing of the Philippine situation, might well serve to indicate to the trustees this more definite idea of the main purpose of the benefaction. As matters stand, the aim is too nondescript to induce confidence.

R. M. W.

THE NATIONAL CONFERENCE COMMITTEE

THE sixth conference of the National Conference Committee on Standards of Colleges and Secondary Schools was held at the rooms of the Carnegie Foundation, 576 Fifth Ave., New York, N. Y., on February 19, 1913. The following delegates were present, representing the organizations indicated:

Headmaster Wilson Farrand, Newark Academy, representing the College Entrance Examination Board,—*Vice-president.*

Professor Frank W. Nicolson, Wesleyan University, representing the New England College Entrance Certificate Board.

Dean Herman V. Ames, University of Pennsylvania, representing the Association of Colleges and Preparatory Schools of the Middle States and Maryland.

Principal Frederick L. Bliss, Detroit University School, representing the North Central Association of Colleges and Secondary Schools.

Dean Frederick C. Ferry, Williams College, representing the New England Association of Colleges and Preparatory Schools.—*Secretary-treasurer.*

Secretary Clyde Furst, as substitute for President Henry S. Pritchett, representing the Carnegie Foundation for the Advancement of Teaching.

Dr. Kendric C. Babcock, specialist in higher education in the National Bureau of Education, as substitute for Hon. Philander P. Claxton, the United States Commissioner of Education.

Dr. George E. MacLean, president of the committee from its establishment in 1906 until 1912, was present by special invitation. The National Association of State Universities and the Association of Colleges and Preparatory Schools of the Southern States were not represented at the conference. The meeting was called by Vice-president Wilson Farrand, who presided at both the morning and the afternoon sessions.

A sub-committee reported the results of an investigation of the use of the terms "honorable dismissal" and "statement of record," which it had made by individual conference and by means of a questionnaire sent to eighty colleges and universities. This report stated that there was a general agreement among the colleges and universities as to the desirability of a standardization of these phrases, as to the acceptance of a student's freedom to continue in the institution issuing the transfer papers as the criterion for the granting of such papers, and as to the great advantage of entire frankness of statement in the issuance of them. The report contained also a resolution defining the proper use of these terms which, after slight modification, was adopted in the following form:

Resolved, That the term "honorable dismissal" should be used to refer to conduct and character only, and that honorable dismissal should never be given unless the student's standing as to conduct and character is such as to entitle him to continuance in the institution granting the dismissal. Furthermore, there should in every instance be given, in the statement of honorable dismissal, full mention of any probation, suspension or other temporary restriction imposed for bad conduct, the period of which restriction is not over when the papers of dismissal are issued.

That the term "statement of record" should be used to refer to the recorded results of a student's work in the classroom, and that this statement should in every instance contain all the important facts pertaining to the student's admission, classification and scholarship. In particular, no partial or incomplete classroom record (for example, with failures omitted) should ever be given without clear evidence that it is partial or incomplete; if the student's scholarship has been such as to prevent his continuance in the institution issuing the statement of record or to render him subject to any probation, suspension or other temporary restriction, the period of which is not closed at the date of the record, a plain statement of any and all such facts should be included; and such information should be given as will make clear the system of grades employed, the number of exercises per week devoted to each course, etc.

The same sub-committee presented a review of some of the difficulties found in the application of the definition of the unit adopted by the committee at its meeting of October 9, 1909, and proposed a resolution providing for the addition of a paragraph to the explanatory statement then formulated. This resolution was adopted so that the entire definition of the unit now stands as follows:

A unit represents a year's study in any subject in a secondary school, constituting approximately a quarter of a full year's work.

This statement is designed to afford a standard of measurement for the work done in secondary schools. It takes the four-year high-school course as a basis, and assumes that the length of the school year is from thirty-six to forty weeks, that a period is from forty to sixty minutes in length, and that the study is pursued for four or five periods a week; but, under ordinary circumstances, a satisfactory year's work in any subject can not be accomplished in less than one hundred and twenty sixty-minute hours or their equivalent. Schools organized on any other than a four-year basis can, nevertheless, estimate their work in terms of this unit.

A four-year secondary school curriculum should be regarded as representing not more than sixteen units of work.

An ambiguity in the interpretation of the definition of the admission Latin requirement announced by the Commission on College Entrance Requirements in Latin in October, 1909, having been brought to the attention of the committee, it was decided to send communications to the chairman of that Commission, to the American Philological Association, and to the College Entrance Examination Board asking that steps be taken to remove the difficulty by an authoritative pronouncement on the subject.

The committee considered the question of the assignment of unit values to the new definition of the admission requirement in English and voted that, as a tentative arrangement, equal values be given to (1) the grammar and composition, and (2) the reading.

Among the questions assigned to a sub-committee for consideration and report at the next meeting are the following: the literal interpretation of the definition of the unit; the greater unit value of the work of the latter years of the secondary school curriculum as compared with the work of the earlier years; the effect on the unit value of work in any subject when it is accompanied or preceded by work in allied subjects; the assignment of unit values to the definitions of the admission requirements in the subjects, algebra, English and history; and the accrediting of candidates for admission to college from secondary schools which give instruction in only one foreign language.

Officers were elected for the year as follows: *President,* Headmaster Wilson Farrand, Newark Academy; *Vice-president,* President A. Ross Hill, University of Missouri; *Secretary-treasurer,* Dean Frederick C. Ferry, Williams College.

The sub-committee which had served for the past two years was continued for investigation and report at the next meeting. This committee includes Headmaster Wilson Farrand, Dean Frederick C. Ferry, President Henry S. Pritchett and Principal Frederick L. Bliss.

The next conference was appointed for February, 1914, or for such earlier time as the sub-committee might select.

FREDERICK C. FERRY,
Secretary

THE DANA CENTENARY

In commemoration of the great geologic work of James Dwight Dana, Yale University proposes to hold a centenary celebration next November, to consist of a series of lectures culminating in a Dana Memorial volume on "Problems of American Geology." The lectures will be given on the Silliman Foundation, the dates to be announced after the opening of the next collegiate year. The lecturers and their respective subjects are as follows:

PROBLEMS OF AMERICAN GEOLOGY

Introduction

"The Geology of James Dwight Dana," Professor William North Rice, Wesleyan University.

I. *Problems of the Canadian Shield*

"The Archeozoic and its Problems," Professor Frank Dawson Adams, McGill University.

"The Proterozoic and its Problems," Professor Arthur Philemon Coleman, University of Toronto.

II. *Problems of the Cordilleras*

"The Cambrian and its Problems," Dr. Charles Doolittle Walcott, Smithsonian Institution.

"The Igneous Geology and its Problems," Professor Waldemar Lindgren, Massachusetts Institute of Technology.

"The Tertiary Structural Evolution and its Problems," Dr. Frederick Leslie Ransome, United States Geological Survey.

"The Tertiary Sedimentary Record and its Problems," Dr. William Diller Matthew, American Museum of Natural History.

SCIENTIFIC NOTES AND NEWS

PRINCETON UNIVERSITY has conferred the degree of doctor of science on Dr. Simon Flexner, scientific director of the Rockefeller Institute for Medical Research and on Dr. David L. Edsall, Jackson professor of clinical medicine in the Harvard Medical School. The degree of master of arts has been conferred on Mr. William Barnum, editor of the publications of the Carnegie Institution.

THE Jefferson Medical College, Philadelphia, has conferred the degree of LL.D. on Dr. Abraham Jacobi, emeritus professor of diseases of children, College of Physicians and Surgeons, Columbia University, and on Dr. Francis P. Venable, president of the University of North Carolina.

DR. E. A. SCHÄFER, professor of physiology in the University of Edinburgh, has received the honor of knighthood. The same honor has been conferred upon Professor J. H. Biles, professor of naval architecture in the University of Glasgow.

The Royal Dutch Geographical Society at Amsterdam has elected Professor W. M. Davis to honorary membership as "master in the art of organizing excursions in the old and the new world, and ingenious founder of a new system of geomorphology."

The Portugal Academy of Sciences has elected Dr. L. A. Bauer a corresponding member.

Admiral Robert E. Peary lectured before the French Geographical Society on the evening of June 6, when the decoration of the legion of honor was conferred on him.

Dr. Henry W. Farnham, professor of political economy at Yale University, has been appointed Roosevelt professor at the University of Berlin by Columbia University and the University of Berlin.

Professor George A. Hulett, who has been on a leave of absence this year from Princeton University and has been acting as chief chemist of the United States Bureau of Mines, will return to Princeton in the fall, and resume his duties as professor of physical chemistry.

George W. Lamke, assistant professor of electrical engineering at Washington University, and Chester H. Hardy, instructor in electrical engineering, have resigned their positions to take up active practise.

T. T. Waterman, assistant professor of anthropology in the University of California, will spend the summer in New York, in part to study the collections in the American Museum.

At the annual meeting of the American Medico-Psychological Association, which ended its sessions at Niagara Falls on June 13, Dr. Carlos F. MacDonald, of New York, was elected president, Dr. S. E. Smith, of Indiana, vice-president, and Dr. Charles G. Wagner, of Binghamton, N. Y., secretary. The association will meet in Baltimore in 1914.

The eighth annual meeting of the American Association of Museums was held in Philadelphia, from June 3 to 5, 1913, with about one hundred members in attendance. Dr. Henry L. Ward, of the Milwaukee Museum, presided. In addition to the reading of papers the program was so arranged as to provide time for the study of important museum collections at the Academy of Natural Sciences, University Museum, Commercial Museum, Wistar Institute of Anatomy, Academy of Fine Arts and Memorial Hall. The officers elected for the ensuing year are: President, Benjamin Ives Gilman, Museum of Fine Arts, Boston; Secretary, Paul M. Rea, Charleston Museum, Charleston, S. C.; Treasurer, William P. Wilson, The Commercial Museum, Philadelphia. The next annual meeting will be held in Chicago with a supplementary session in Milwaukee.

Immediately after the resignation of professor Willis L. Moore as chief of the Weather Bureau had been accepted by the President, charges were filed against him with the Secretary of Agriculture by responsible men in the service. Those charges, which related to the improper conduct on the part of Professor Moore in connection with his candidacy for the office of secretary of agriculture, were of such a grave nature that the Department of Justice was asked to make an investigation. This investigation has now been practically completed. The facts secured from the preliminary investigation were sufficient to warrant the President in withdrawing his acceptance of Professor Moore's resignation and removing him summarily from the service, which was done April 16, 1913. Charles T. Burns, an employee of the Weather Bureau, was furloughed at the same time, but later reinstated with reduced rank and salary. On June 7, as a result of the investigation by the Department of Justice, six other employees of the Weather Bureau were furloughed without pay, and thirty-one other officers and employees whose salaries had apparently been increased by Professor Moore as a reward for their activities on his behalf were reduced to their former salaries.

Professor Albert Perry Brigham, of Colgate University, will go to Europe in July to remain during the coming academic year. In

his absence Professor Isaiah Bowman, of Yale University, will be the acting secretary of the Association of American Geographers and will prepare the program for the Princeton meeting. Professor Bowman is expected to return from South America in September.

PROFESSOR HOWARD S. REED, of the Virginia Polytechnic Institute, who is spending the year in Europe was a delegate to the Tenth International Congress of Agriculture held in Ghent from June 8 to 12.

ARTHUR H. BLANCHARD, professor of highway engineering in Columbia University, sailed on June 12 to attend the Third International Road Congress, London. Professor Blanchard is a United States reporter on Question 3, "Construction of macadamized roads bound with tarry, bituminous, or asphaltic materials," and Communication 10, "Terminology adopted or to be adopted in each country relating to road construction and maintenance." He has been appointed a delegate to the congress by Columbia University, the American Society of Civil Engineers, the National Highways Association and the American Road Builders' Association.

A SPECIAL research meeting was held by the Royal Geographical Society of London, on June 4, at which Dr. L. A. Bauer gave an account of the progress of the magnetic survey of the oceans and of the chief results thus far obtained. The paper was discussed by Sir David Gill, the presiding officer, by Drs. Shaw and Chree, and by Captain Creak and others.

PROFESSOR H. H. DONALDSON, of the Wistar Institute of Anatomy and Biology, Philadelphia, delivered the commencement address at the St. Louis University School of Medicine on June 5, the subject being "The Mutual Relations of Medical Progress and the Physician."

THREE Chadwick public lectures, on "Nature and Nurture in Mental Development," are being given by Dr. F. W. Mott, F.R.S., at the Royal Society of Arts, on June 6, 13, and 20.

MR. FREDERICK ALBION OBER, an explorer and the author of works on ornithology and travel, died in Hackensack, N. J., on June 1, aged sixty-four years.

PROFESSOR L. G. LEÓN, general secretary of the Mexican Astronomical Society, has died at the age of forty-seven years.

THE death is also announced of Dr. Léon Pervinquière, lecturer on paleontology in the University of Paris.

MR. ARTHUR JAMES has given as a memorial to his brother the income of a sum of 20,000*l.* for cancer research to the Middlesex Hospital, London.

THE Bureau of Standards, Department of Commerce, expects to begin, soon after July 1, the inspection of railroad scales, starting with some of the scales of the eastern roads. This test will be made as a result of complaints from shippers as to the weights charged for by railroads, which have recently drawn attention to the necessity for some governmental supervision over railroad track scales, as well as scales used by shippers doing an interstate business. Every grocer's scale is supposed to be tested as to its accuracy periodically in order that the purchasers may be assured of getting correct weight. In addition, the city or county sealer sees to it that the purchaser secures full weight or measure, and prosecutes violations of the law by the dealers. On the other hand, the railroads annually collect approximately $2,200,000,000 from the shippers of the country on scales which belong to and are operated entirely by the roads, and over which neither the shipper nor the Government has any control or, indeed, any information as to the correctness of the scales. In order to secure information that will enable the Government to draw reliable conclusions as to what shall be done to guarantee the accuracy of railroad weights, and also for the purpose of aiding the railroads to install correct scales, the Bureau of Standards was allowed an appropriation of $25,000 by Congress for the purchase of a test-weight car equipment. The contract for this car has already been let, and it is expected that the car will be delivered soon after July 1, when the appropriation becomes available. The equipment ordered by the

Bureau will differ radically in principle from any in use. Instead of the wheels, brakes, and other movable parts of the car constituting part of the standard weight, as is customary, the Bureau proposes to carry a series of 10,000-pound weights and a truck for moving them on the scales, in a specially designed car provided with a power crane and other accessories for handling the weights. The advantage of this arrangement is that the weights may be standarized and transported from one end of the country to the other with a reasonable assurance that they will remain constant, whereas if the running gear is included in the weight of the test car it would be necessary to verify this weight at frequent intervals. After testing a scale with the standard weights, the empty car may then be put on the scale and its weight determined, after which the weights may be loaded into the car and the scale tested up to the full capacity of the car plus the standard weights.

The eighty-first annual meeting of the British Medical Association will be held at Brighton, July 22–25. According to the *Journal* of the American Medical Association in the section of bacteriology and pathology the papers will include one by Dr. Miller Galt on "The Value of the Blood-count in Obscure Bacterial Infections," and an account by the staff of the John Howard McFadden Research fund on "Some Researches on the Jelly Method of Staining Cells Alive." A joint discussion has been arranged with the section on pharmacology on "Anaphylaxis," the papers promised including a consideration of "The Action of Asbestos and other Finely-divided Substances on Various Physiologic Substances." In the section of climatology and balneology there will be discussions on "Sea Bathing," to be opened by Dr. W. J. Tyson, and on "The International Aspects of British Health Resorts," to be opened by Dr. Neville Wood. In the section of diseases of children, Dr. E. J. Poynton and Dr. Carey Coombs will initiate a debate on the "Affections of the Heart in Childhood." In the section of electrotherapeutics papers and discussions have been arranged on "Röntgen Diagnosis," on "Electrodiagnosis and Electrotherapeutics" and on "Röntgen Therapy and Radium." The subjects chosen for discussion in the section of medical sociology are "Crime and Punishment," on which Dr. Charles Mercier, Sir Bryan Donkin and Dr. James Scott will read papers, and on "Hospitals in Relation to the Stage, the Public and the Medical Profession," in which Sir Henry Burdett and Dr. I. G. Gibbons will read papers. The discussion will, it is hoped, prove valuable in helping to elucidate the problems involved in providing hospital accommodation for insured persons under the national insurance act. A discussion on "Eugenics" will be introduced by Professor Bateson, to be followed by Dr. Stewart Mackintosh, and Mr. Chas. B. Davenport, of New York. The arrangements for the navy, army and ambulance sections include a paper by Major Birrell on "Notes on the Work of a British Red Cross Unit with the Bulgarians."

A British Blue Book has been issued giving statistics of the number of persons killed by wild animals and snakes in British India from 1880 to 1910. According to the summary in the *British Medical Journal* the figures show that the tiger is the animal most destructive to human life; during the last five years of the period it was responsible for 38 per cent. of the total number of deaths caused by wild animals, leopards accounting for 16, wolves for 12 and bears for 4 per cent. Of the total number of persons (2,382) killed by wild animals in the year 1910, the tiger accounted for 882, the leopard for 366 and wolves and bears for 428. Elephants and hyenas, the two other animals distinguished in the returns, were between them responsible for 77 deaths in 1910. Of the 629 deaths attributed to "other animals," 244 are assigned to alligators and crocodiles, 51 to wild pigs, 16 to buffaloes, 24 to wild dogs and 220 to unspecified animals. In 1910 there were 22,478 deaths from snake-bite, compared with 21,364 in the previous year, but Bombay was one of the provinces which did not contribute towards the increase, and is in other respects one of the more fortunate parts of India. In Bengal, for ex-

ample, 1,180 persons were killed in 1910 by wild animals and 7,767 by snakes; but Bombay is, with the exception of the Punjab, at the bottom of the list with 22 deaths by wild animals and 1,247 by snakes. The statistics regarding the number of cattle killed by wild animals are not very perfect, but it is estimated that in the five years ending 1910 the number of animals killed was about 100,000, leopards accounting for 48 per cent. and tigers for 32 per cent.

UNIVERSITY AND EDUCATIONAL NEWS

COLUMBIA UNIVERSITY, Rutgers College and the Reformed Church in America receive bequests which may amount to $1,000,000 each as the three principal beneficiaries under the will of Mrs. Mary B. Pell, who died on May 26 at 182 Riverside Drive, and was the widow of John H. Pell. Each beneficiary received a direct bequest of $200,000 and an interest in large trust funds aggregating more than $2,000,000. The bequest to the Reformed Church is for the purpose of building the Wessels Memorial Hall at the theological seminary at New Brunswick, N. J., and the same name is to be adopted for a memorial hall to be erected with the bequest to Rutgers. The fund for Columbia is to erect Pell Hall, in memory of the decedent's husband, who was an alumnus of Columbia.

PRINCETON UNIVERSITY has received $100,000 from Mrs. Russell Sage toward the construction of a dining hall.

GOVERNOR SULZER has signed bills appropriating $450,000 for the College of Agriculture of Cornell University, which also receives $125,000 in the supply bill. The appropriation for the veterinary college is $70,000. A part of the additional appropriation this year is to be used for increasing salaries.

THE bill taking over the College of Physicians and Surgeons by the University of Illinois was advanced to its third reading in the legislature, on June 5, after the defeat of amendments offered by those opposing the project. The state is being asked to appropriate $200,000 for maintenance of the institution, this being a part of the $4,300,000 appropriation asked for the University of Illinois.

THE Plant Industry Hall of the University of Nebraska, containing the departments of agricultural botany, entomology, experimental agronomy and horticulture was dedicated on June 10, the address being made by Professor John M. Coulter, professor of botany in the University of Chicago.

THE following appointments have been made to the faculty of the new school of technology of the Johns Hopkins University: Professor C. C. Thomas, of the University of Wisconsin, to the chair of mechanical engineering; Professor C. J. Tilden, of the University of Michigan, to the chair of civil engineering; and Professor J. B. Whitehead, hitherto professor of applied electricity in Johns Hopkins University, to the chair of electrical engineering.

E. DANA DURAND, former director of the United States Census, has accepted the position of director of the Bureau of Research in Agricultural Economics, at the Minnesota Agricultural College.

PROFESSOR PIERRE BOUTROUX, of the University of Poitiers, France, has been elected professor of mathematics at Princeton University.

DR. R. G. HOSKINS, Ph.D. (Harvard, '10), has been appointed associate professor of physiology in the Northwestern Medical School. Dr. Hoskins, who has been working on internal secretions, will devote three fourths of his time to research and one fourth to teaching.

CHARLES T. KIRK, Ph.D. (Wisconsin, 1911), has been appointed professor of geology in the University of New Mexico. According to the State law of 1909, establishing a Natural Resources Survey, Mr. Kirk becomes ex-officio state geologist, and will spend the present summer in reconnaissance work in that capacity, with headquarters at Albuquerque.

DR. EDWARD C. DAY, Harvard foreign fellow, Naples, Italy, has been elected instructor in zoology, Syracuse University. Dr. M. W. Blackman, of the department of zoology, Syracuse University, has been elected associate professor of entomology in The New

York State College of Forestry, Syracuse University.

At the Alabama Polytechnic Institute, Auburn, Alabama, changes in the staff have occurred as follows: Dr. E. P. Sandsten, professor of horticulture and state horticulturist, resigns to accept a similar appointment in Colorado State College. A. B. Massey, formerly assistant professor of botany and bacteriology in Clemson College, becomes assistant professor of botany. H. N. Conolly, field agent in horticulture, resigns to accept similar work in Colorado State College. Charles S. Williamson, Jr., formerly assistant professor, is promoted to associate professorship in the department of chemistry. Jesse M. Jones is appointed head of the department of animal industry, succeeding Dan T. Gray, who has accepted a similar position in the North Carolina Agricultural College.

The Board of Agricultural Studies of the University of Cambridge, in consultation with the president of the Royal Agricultural Society, has nominated Mr. C. R. Fay, M.A., Christ's College, to be the Gilbey lecturer on the history and economics of agriculture.

DISCUSSION AND CORRESPONDENCE

THE CHARACTER OF THE ENDOSPERM OF SUGAR CORN

In a recent publication[1] dealing with the F_2 generation of a cross between two forms of *Zea Mays*, the one with sugar endosperm, the other with waxy endosperm, the existence of two alternative factors, one for sugar (S), the other for waxy (X) is assumed. Absence of S results in waxy endosperm, absence of X results in sugar endosperm. When both are present a horny endosperm results. The F_2 generation, involving 22,132 kernels, consisted of those with horny, waxy and sugar endosperm in a proportion closely approximating the 9:3:4 ratio.

The assumption of two alternative factors does not meet the requirements, since on this basis a ratio 9:3:3:1 is to be expected. On the basis of Mr. Collins's theory, too, a zygotic construction $ssxx$, involving $\frac{1}{16}$ of the F_2 generation should result in neither a waxy nor a sugar endosperm. Yet the numerical results clearly indicate a sugar endosperm for this portion of the F_2 generation. ("Careful scrutiny of the sweet seeds failed to show any consistent differences that would allow another class to be separated, . . .").

A more plausible explanation suggests itself in an analogy to Cuénot's hybrids between agouti and albino mice. Assuming a basic factor S, responsible for the sugar endosperm, a factor W, which, acting together with S, produces a waxy endosperm, and a modifying factor H, which acting together with the factors W and S produces a horny endosperm, I would suggest for the zygotic constitution of sugar corn $HHwwSS$, and for the zygotic constitution of *Zea Mays* with waxy endosperm $hhWWSS$. On this basis the F_1 generation of a cross sugar $\times$ waxy should possess the zygotic constitution $HhWwSS$, which, according to our premises, should result, and in fact does result, in a horny endosperm. Selfing of the F_1 generation should yield the following combinations:

HWS HWS	HwS HWS	hWS HWS	hwS HWS
HWS HwS	HwS HwS	hWS HwS	hwS HwS
HWS hWS	HwS hWS	hWS hWS	hwS hWS
HWS hwS	HwS hwS	hWS hwS	hwS hwS

The combinations $HHWWSS$ (1), $HHWwSS$ (2), $HhWWSS$ (2) and $HhWwSS$ (4), should result in a horny endosperm, since they contain all three factors; the combinations $HHwwSS$ (1), $HhwwSS$ (2) and $hhwwSS$ (1), should yield a sugar endosperm, since the factor W is lacking, and the combinations $hhWWSS$ (1) and $hhWwSS$ (2) should produce a waxy endosperm, since the modifying

[1] Collins, G. N., and J. H. Kempton, "Inheritance of Waxy Endosperm in Hybrids with Sweet Corn," U. S. Dept. Agric., Bur. Pl. Ind., Circular 120, 1913.

factor H is lacking. Therefore horny, sugar and waxy endosperm should be represented in the proportions, actually found, 9 : 4 : 3.

To test for the presence or absence of the factor H, here suggested, in sugar-corn a cross should be made with homozygous waxy. Three kinds should be found, the first ($HHwwSS$) yielding horny endosperm only, the second ($HhwwSS$) yielding 50 per cent. horny and 50 per cent. waxy and the third ($hhwwSS$) yielding waxy only.

HENRI HUS

UNIVERSITY OF MICHIGAN

THE YELLOWSTONE PARK

TO THE EDITOR OF SCIENCE: In a letter relating to Yellowstone Park which appeared in the issue of SCIENCE for March 21, 1913, there were some statements concerning the experiences which tourists camping out in the park ("sage-brushers," they are usually called) have with the bears, which are certainly astonishing to those who can speak for the sagebrushers if not for the bears. The "cleaning out of sagebrushers' camps by marauding bears" was spoken of as a "nightly occurrence" and it was stated that "three or four sagebrushers are killed nearly every summer in attempting to drive bears out of their camps." My experience as a sagebrusher is that bears will indeed attack the vulnerable part of the camp—the locker containing the store of bacon and the lard can—but even in the vicinity of the Canyon of the Yellowstone, where bears are most numerous, the repelling of an attack on the larder took on much the nature of a midnight sally to rout the neighbor's cow from one's garden patch. There was the same spontaneous rallying against the invasion, the violent laying about with whips and clubs, the resort to loud and picturesque language, and the same clumsy and precipitate retreat of the culprit. Once only we thought it necessary to resort to extreme measures which was to play upon the invaders with a Roman candle. This was completely effective. I would not have a single person miss the great fun and superior advantage of camping out during the tour of the park because of the fear of the bears.

A statement from Lieutenant Colonel L. M. Brett, acting superintendent of the park, under date of April 5, 1913, should certainly reassure all who contemplate a camping trip. I quote as follows:

> As a matter of fact, no tourist or other person has ever been killed by a bear in the park, so far as is known in this office. Our regulations prohibit feeding or meddling with bears, but it is a great temptation for every one to feed them and make pets of them, and the regulations are sometimes violated. Otherwise, there would seldom be any bad bears in the park. As it is, we have instances where the bear becomes dangerous to life and property, and it is necessary to dispose of it. This is done by capture alive and shipment by express to some city zoo, when there is a demand for a bear, and in case there is no demand for it, it is shot. A few instances are on record where people have been attacked and injured by bears. One of these was a tourist; the others were employees of hotels, etc., in the park. In all cases where the facts were known, the person injured was more or less to blame for his own misfortune.

JESSE L. SMITH

THE METRIC SYSTEM OF WEIGHTS AND MEASURES

TO THE EDITOR OF SCIENCE: I agree with all that Professor A. H. Patterson says regarding the greater simplicity and general desirability of the metric system of weights and measures, but there is, perhaps, something that may be profitably said concerning his reference to "those selfish interests which are blocking the way of reform."

Chief among these interests, perhaps, are the machinery-making concerns of the country, and if Professor Patterson were responsible for the conservation of the capital invested in measuring tools, gauges, fixtures, etc., based upon the present system of measurement, and if he believed that a change to the metric system would make it necessary to discard these tools and gauges, he would, I fear, be strongly tempted to object to the introduction of the metric system, notwithstanding his perception of its superiority.

The very general objection of the American machinery constructors to the introduction of the metric system is based upon the belief that the capital above referred to would be thereby sacrificed. A curious feature of the case, however, is that it has been, and can at any time be demonstrated that no such sacrifice would be involved, and therefore the serious objection, which comes from machinery-building interests, to the taking of any step toward the introduction of the metric system, is based upon an entire misconception. This misconception is due chiefly to the fact that most machinery manufacturers do not themselves take the time and trouble necessary to look into this matter, but have taken at par the statements of one or two extreme opponents of the present heterogeneity called a system. These opponents have represented and have made many others believe that the change to the use of the metric system would necessarily mean an alteration in the actual dimensions of machinery now built, and of the tools used in connection with that machinery.

The fact that machinery-building establishments in this country are regularly using the metric system, and are applying it to the identical machines previously made to the English system, without any alteration whatever in the machines themselves, or in the tools for making them, seems to have no weight, and because a matter of dollars and cents is involved, and deep-seated prejudices have been aroused, practically no hearing can be obtained for the manifest advantages of the metric system. The columns of the trade journals are practically closed to all discussions of it, and whenever the subject is up for discussion, by a committee of congress, representatives of, or those professing to represent, the machinery-building interests, will oppose any step taken toward progress in this matter.

Even when it was proposed simply that the various departments of the United States government should make use of the metric system, it was strenuously opposed on account of what it was feared it would lead to, although it was evident that whatever of extra expense might have been involved in the use of the metric system by the government departments would have been borne by the government itself, and would, therefore, have been distributed in such a way as to have been unperceived; even granting that there would have been any extra expense, which is by no means demonstrated and is doubtful.

I mention this matter only to show what the nature of the opposition to the metric system is, and from whence the strength of such opposition comes. It is based upon primary considerations which would be justifiable, or at least quite excusable, if there were any foundation for them. It is my belief that there is practically no foundation for them.

FRED J. MILLER

THE TEACHING OF ENGLISH COMPOSITION

TO THE EDITOR OF SCIENCE: I sympathize with Professor Robinson in his concern over the unhappiness of the teacher of English composition, and approve of all he says; but he does not go far enough. He does not answer his own question: "What are we to do to keep him [the teacher] happy in English composition?"

He divides the men in charge of classes in English into two types: the "educator"—who "draws out" his pupils, reads themes less and plays golf more, and from whom the students draw culture in the vaguer sense, a dissemination of sweetness and light—and the "teacher," whose conference work is "confined mostly to grammar, punctuation and the split infinitive; but in the class he finds nothing to do that he considers worth while."

It is a common fault of teachers and of scientific men that they are always trying to divide things, and men, into types and classes, to put them into pigeonholes and label them. What Professor Robinson should do is to try to discover a man who combines the best characteristics of both "educator" and "teacher" and who can not be put in the pigeonhole with either label. If there is no such man to be found, perhaps one can be made. Start with a "teacher" who "hates inexactness and vagueness," and "loves to enforce a clear

intellectual distinction." Make him drop his conferences on "punctuation, grammar and the split infinitive" (I suppose the last two words refer to the latitude of Boston; the rest of the country does not bother itself about the split infinitive) and let his students "criticize their own compositions and those of one another" on these points, as the "educator" does. Let him "read themes less and play golf more," and let him, like the "educator," disseminate the culture of sweetness and light. Give him the right kind of a text-book, with some logic in it, even with the "Barbara, Celarent"—which is a good thing to have in the text-book for reference, although it need not be memorized.

Why should not such a man be found? A teacher, or an educator, like every other man, is the product of heredity and environment, also of habit and of the kind of boss he has—which last may be considered part of his environment. The heredity of the teacher, in Boston at least, is all right; his environment is fairly good, but his teaching habits are bad and he has not been properly bossed; therefore he is unhappy. He is supposed to be teaching English composition, but he is not; he is reading "themes" and correcting errors of grammar and punctuation; he is doing the work that should have been done in the grammar school. "This man of solid thoughtful mind is the only real teacher." Yes, but he is unhappy, and he needs a boss to direct him how and what to teach, and how to "educate," and how to be happy, though a teacher.

Can a boss be found? Why not? Is there not in Harvard some authority that can get the "teachers" and the "educators" together around a table and say to them: "Show us the results of your teaching and educating. Do your graduates have 'mechanical perfection in technique' and there stick; have they style, or do they 'write with the mechanical regularity of one pumping into a bucket'? What proportion of them write even passable English? If the results are not what they should be, get together, you teachers and educators, and plan a better method. If you can not plan one, do as the football players do, hire a coach to plan the method, and let him be your boss until you can show results with it."

"Some day there will be a shaking among these dry bones." Why not now?

WILLIAM KENT

MONTCLAIR, N. J.

UNIVERSITY LIFE IN IDAHO

TO THE EDITOR OF SCIENCE: Permit me to state, in reference to the question of veracity between President James A. MacLean, of the University of Manitoba, and Professor V. L. Kellogg, of Stanford University, that at the request of Professor Kellogg I furnished him with a rather full statement of the facts concerning my recent separation from the University of Idaho. From what I wrote him he prepared his article published by you under the caption "University Life in Idaho." It contains no material statement not furnished by me, and none which I do not at the present time fully believe to be true, notwithstanding President MacLean's denial. In fact, most of the details are matters of common knowledge, which no one could deny in Moscow, Idaho, though it might be done in Winnipeg.

As it is obviously impossible to try the case in your columns, I must be content to assume full responsibility for the essential correctness of Professor Kellogg's article.

J. M. ALDRICH

BUREAU OF ENTOMOLOGY,
WASHINGTON, D. C.,
June 8, 1913

SCIENTIFIC BOOKS

The Space-Time Manifold of Relativity, the Non-Euclidean Geometry of Mechanics and Electromagnetics. By EDWIN B. WILSON and GILBERT N. LEWIS. Proc. Amer. Acad. Arts and Sci., Vol. 48, No. 11. November, 1912. Pp. 120.

Probably the most startling scientific conclusion of the past was the assertion that the earth moved. Even yet, while every one would probably assent passively to this state-

ment, it is doubtful if many persons actually construct their idea of the universe so as to make this motion of the earth a reality. It is not many years since the assertion of Poincaré that the rotation of the earth is a hypothesis, met with as much glee in some quarters as it did astonishment in others. When the average man says that so far as he is concerned, the earth is stationary, he means practically that none of the experiences he has had lead him to think of the earth as in motion. When, however, he becomes a physicist, and tries to harmonize the motion of Foucault's pendulum with his ideas of mechanics, or the deviation of a falling body from the vertical, or the motion of storms across the surface of the earth, he is led to assert as the simplest explanation that the earth must rotate. When he becomes an astronomer and endeavors to reduce the varying configurations of the heavens to some kind of simplicity, he is ultimately led to assert that the earth is moving in space. He is thus brought to consider the question, is the whole universe in motion? and how can its motion be detected? At once he remembers Archimedes's remark: Give me a fulcrum and I will move the world. What is the fulcrum? Here is the trouble. If the earth may be thought of as moving around the sun, the sun may be thought of as moving around the earth. If the mountains and oceans of the earth can turn smoothly around once every twenty-four hours why can not the heavens turn? The problem comes home and must be phrased thus: How can the absolute motion of the earth be proved? Was Galileo right when he said: *E pur si muove*.

We turn first to dynamics for help, but we find that its laws will not avail. The fundamental law is that the rate of change of the momentum of a moving body is proportional to the force acting, where force and momentum are taken as directed quantities. But if we locate the moving particle with respect to an origin which itself is moving uniformly in a straight line we can not detect the fact that the origin is in motion, for the law holds equally well in either case; that is to say, change in momentum is measured by a difference of velocities and can never give us the absolute value of velocity itself. This is the relativity principle of ordinary mechanics. Conversely, if we agree that all we know of the kinetic energy of a particle is that the increment of the energy is measured by the work done by the external force in moving the particle an infinitesimal distance, and that this is invariant for a system whether it is at rest or in motion, with a uniform rectilinear velocity, then all the equations of dynamics are deducible from this basis.

Since dynamics gives us no help, we turn to electrodynamics. There is here a constant which seems to be an absolute constant, the velocity of light. It would seem that if light is a movement or a disturbance in a stationary ether, then we should be able to detect the motion of the earth against this ether. Aberration indeed seems to indicate that we have found our fulcrum. But other experiments seem to show that if there is an ether, it moves with the earth. And the only apparent way to reconcile all the experiments seems to be the assumption of certain laws which make the hypothesis of an ether superfluous. The physicist is here hard pressed for a satisfactory substitute. When the fundamental equations of electrodynamics are examined mathematically, it is found that certain changes can be made in the variables of these equations without affecting the form of the equations. In the new variables the equations read just the same as in the old. That is to say, for certain moving systems the equations are of the same form as for a stationary system. Consequently the quantities involved can only be determined relatively.

The specific statement of the case is this:

Let one end of our laboratory table be our origin, and we will suppose that with respect to an omnipresent stationary observer who appreciates distance and time directly, the origin is in motion in a straight line with uniform velocity, v. The velocity of light we will represent by c, and we will suppose that any velocity can be measured absolutely. This is our first assumption. Then if the fol-

lowing things happen to be facts, we can not ever hope to detect the absolute motion of the table by experiments on light or electricity.

1. If there is a bar AB on the table pointing in the line of the motion, to the stationary observer its length would be only $AB\sqrt{(1-\beta^2)}$ where $\beta = v/c$.

2. The time on a clock at A on the table would read less in the same ratio, that is, if the motion began at noon, when the stationary observer knew that the time was really t the clock would read $t\sqrt{(1-\beta^2)}$.

3. A clock at B could not be made to read the same as a clock at A at the same instant but would be behind that at A by

$$\frac{AB}{v}\,\frac{\beta^2}{\sqrt{(1-\beta^2)}}.$$

If a clock were instantly moved from A to B the hands would instantly shift through that amount. This is the principle of *local time.*

The stationary observer would deduce at once some very startling conclusions, such as these. If the table could move with the velocity of light, $\beta = 1$, and the length of AB would be nothing at all. The clock at A would cease to register time at all. The obvious conclusion would be that the velocity of light is a maximum that no velocity could ever reach. But even for velocities below that of light we have to give up the idea of incompressible bodies. Energy and mass become confused and physics has to be remade. And the difficulty of time being attached to the place at which we are, so that no time meter could be devised which could be moved around and retain its correct reading, is disturbing. If two clock faces are at the ends of a long axis, and read together when across the line of motion, why should there be a twist in the axis when it is turned into the line of motion?

To enable one to understand these proposed relations of distance and time, Minkowski conceived the notion of giving them a geometrical setting. This is nothing new in physics, for many models have been made to represent various laws and hypotheses. They enable us to look at the relations in a much more direct way; to be able, as it were, to look over a map of the ground. It must be borne in mind, however, that such representations are not substitutions for the thing itself. A temperature-entropy diagram is not steam in a boiler, of course, but only shows certain relations as to the steam in the boiler. So too, Minkowski's geometric setting of relativity is not a picture of the world, but a representation of the relations that are set forth in the theory of relativity.

His suggestion was that if we use a four-dimensional space, measuring x, y, z (which give us the position of the laboratory table) along three axes, and measure on the fourth axis the distance ct, then the fourth axis can be spoken of as a time axis, since c is a constant. In this way we can speak of the situation of the real world at time t as a section in the four-dimensional world by moving a space of three dimensions. The idea is easily illustrated by imagining a wave on a pond made by a stone dropped into the water. The wave spreads out with a given velocity. If now we construct a cone of the proper angle, immerse the point at the center of the wave and let the cone sink at the right speed, the expanding wave will always remain in contact with the cone. Or, so far as geometry is concerned, we can keep the cone stationary and let a cutting plane move upward. The circular section on the plane will then appear to expand like a wave. In an analogous manner we can at least get a phraseology that will describe the ideas underlying relativity of the electrodynamic kind. It turns out that if we represent these in a four-dimensional space the whole statement of the relativity property can be summed up in one simple statement, that is: In the four-dimensional space the choice of our axes of reference is fairly arbitrary. We may take axes inclined at the proper angle to our original axes, as new axes of reference, and the equations for the new x', y', z', t', are just like the original equations. Indeed if we suppose the table mentioned above to move along the x axis, as viewed by a stationary observer, with a uniform velocity v, which we may set equal to $c \tanh \phi$, where $\tanh \phi = \beta$, $\tanh^1$ being the

symbol for hyperbolic tangent, we may write the equations of transformation in the form

$$x = x' \cosh\phi + ct' \sinh\phi,$$
$$ct = x' \sinh\phi + ct' \cosh\phi.$$

That is, if one end of the table, say B, is apparently to the moving observer at a distance x' ahead of the other end, which is the moving origin, A, then the stationary observer knows that the real stationary distance is $x' \cosh\phi$. If the clock at B reads t' to the moving observer, then the stationary observer knows that the time which has elapsed from the beginning of the motion is really $t' \cosh\phi$; and at velocity v, this means that the origin A has moved away from the stationary origin a real distance $vt' \cosh\phi$ or $ct' \sinh\phi$. Hence the real distance of B from the stationary origin is

$$x = x' \cosh\phi + ct' \sinh\phi.$$

Also the stationary observer knows that the clock at B is off from two causes, one its position, at a distance apparently x' from A, which sets it back really by

$$\frac{x'\beta^2}{v\sqrt{(1-\beta^2)}},$$

that is,

$$\frac{x' \sinh\phi}{c}.$$

The other cause is that the time read on the clock since the motion began is t', but the real time as seen by the stationary observer, is $t' \cosh\phi$. Hence we have the equation

$$ct = x' \sinh\phi + ct' \cosh\phi.$$

From these equations the stationary observer could compute x', which the moving observer would think was the distance of B from his moving origin, and the time t' on his moving clock. We have

$$x' = x \cosh\phi - ct \sinh\phi,$$
$$ct' = -x \sinh\phi + ct \cosh\phi.$$

These equations evidently are much like the first pair, and indeed we see that if we change the sign of ϕ, that is, of β, or finally of v—which means that we imagine the moving observer to be at rest and the stationary observer to be relatively in motion—we have the second set. We would therefore expect that if we have two moving observers, with different velocities v and v', we would find similar equations for their respective interpretations of each other's data as to distance and time. Thus indeed if

$$x = x'' \cosh\psi + ct'' \sinh\psi,$$
$$ct = -x'' \sinh\psi + ct'' \cosh\psi,$$

we find x' and ct' to be in terms of x'' and ct'',

$$x' = x'' \cosh(\phi-\psi) - ct'' \sinh(\phi-\psi),$$
$$ct' = -x'' \sinh(\phi-\psi) + ct'' \cosh(\phi-\psi).$$

We see at once from this that the relative velocity is not found by getting the difference of the velocities v and v', but by getting the difference of ϕ and ψ, that is, the relative velocity is

$$\tanh(\tanh^{-1} v - \tanh^{-1} v').$$

After this long preliminary we come to the paper before us which presents a full study of the geometrical representation of these facts, in a most elegant manner. The formulæ above are interpreted as representing a rotation in a four-dimensional space, but not a common space. The rotation in a common space would involve the $\sqrt{-1}$, and to preserve the real numbers as reals, the space chosen is a non-Euclidean space. After all, the difference is really this, that certain terms like *rotation*, *perpendicular*, etc., do not mean what they ordinarily do, but have meanings related to a given hyperbola, rather than to a given circle. Thus really *perpendicular lines* through the origin are conjugate diameters of a circle whose center is the origin. In the paper "*perpendicular*" still means *conjugate*, but as to a hyperbola and not a circle. This illustrates sufficiently the way in which the terms appear. Only a careful study of the paper itself can give a clear idea of the character of the presentation. The reader simply needs to be on the alert as to the geometrical meaning assigned here to familiar terms whose meaning has been altered.

[1] $\sinh\phi = \beta/\sqrt{(1-\beta^2)}$, $\cosh\phi = 1/\sqrt{(1-\beta^2)}$, $\operatorname{sech}\phi = \sqrt{(1-\beta^2)}$.

The algebraical character of the paper needs a word. Instead of using a coordinate system and ordinary algebra, the authors develop a vector-algebra whose expressions represent directly the geometrical entities under discussion, and which in itself is unchanged by the changes in the axes of reference. This algebra is based upon the notions of Gibbs, and is the same as was developed by Lewis.[1] A rather complete development is given, including the analysis, or differential calculus of these vectors. In terms of the constancy of one of the vectors defined, the vector of extended momentum, the laws of conservation of mass, energy and momentum, are deduced, as well as fields of gravitational force and potential. It is not possible to enter into detail, as the technical character of the developments would demand a large amount of space to do them justice. However, any one desiring a complete and elegant account of the relativity theory, as it is seen in a geometric setting, will find it here. The laws of electromagnetics and mechanics are seen to be theorems in this geometry, which means of course that the representation as a non-Euclidean geometry of four dimensions is not only a fair representation, but is a complete representation of all the facts. It is not to be concluded, however, that it is the only representation; others have been suggested, which do not introduce the notion of a four-dimensional space in the sense it has above.[2] It should be pointed out, however, that the electrodynamic equations remain unaltered if we substitute a distance X for ct and at a time for x given by cT. So that if the universe is four-dimensional and we are moving with the velocity of light in one of the four directions of the fundamental axes, we can not tell which one it is, and indeed it makes no difference. Which means in the end (does it not?) that as we assumed in the beginning that the only thing we could measure absolutely is velocity, therefore, all distances must be expressed as velocities, that is, as times, or conversely, that time as we view it is a distance. Indeed this is the fundamental assumption of the whole theory, that we may never know correctly absolute distance (if there be such a thing) nor absolute time, but we do know correctly absolute velocity.

[1] *Proc. Amer. Acad. Arts and Sci.*, 46: 163–182.

[2] Timerding, *Jahresb. d. Math. Ver.*, 21: 274–285, 1913.

The memoir is interesting also to mathematicians as a study of a particular non-Euclidean space and the corresponding vector algebra. It illustrates in a very happy way the great simplification introduced into a problem when we apply the proper symbolic analysis.

JAMES BYRNIE SHAW

Introduction into Higher Mathematics for Scientists and Physicians. By DR. J. SALPETER. Jena, Verlag von Gustav Fischer. Pp. 336.

This book has the advantage—as compared with similar previous works—of being written in a very elementary and yet thoughtful fashion. The author has succeeded very well in explaining the principles of higher mathematics in an exceedingly plain way, yet so that he gives all the essential points. For instance, the first three chapters of the book (32 pages or about one tenth of the whole book) are exclusively devoted to a most detailed and elaborate explanation of the three fundamental conceptions upon which higher mathematics are based. These are: (1) the conception of the limiting value of an infinite series of figures; (2) the conception of a function; and (3) the conception of the derivation of a function. To explain the importance and real meaning of these fundamentals the author uses much space, and especially cites a great number of examples from different domains of natural science. In view of the purpose of this work, however, this explanation is not too long. After this introduction only, the technique of differentiating is discussed, also very clearly. Maxima and minima of functions, differential equations, integration, etc., are then explained thoroughly and clearly. At the end of each chapter numerical examples are given, as well as applications to scientific problems. The graphic method is extensively used. As a whole, the book can be recommended to such experimental investigators

who wish to make themselves acquainted with mathematical methods in a limited time. The importance of mathematics for all branches of natural science will certainly increase the more our knowledge progresses and increases in complexity, because it becomes more and more difficult to draw conclusions by non-mathematical reasoning. A book of such character as the one described can certainly therefore claim to be of great importance.

R. Beutner

Rockefeller Institute

Chloride of Lime in Sanitation. By Albert H. Hooker. First Edition. New York, John Wiley & Sons. 1913.

One of the most striking developments in the art of water purification during recent years has been the rapid increase in the use of chloride of lime as a disinfectant. It has been found that astonishing results may be obtained by the use of surprisingly small quantities of this substance. In clear water, such as that of the Great Lakes, the application of eight to ten pounds of this chemical to a million gallons of water is sufficient to destroy practically all of the bacteria. Larger amounts are required for waters which contain organic matter, in some instances nearly one hundred pounds per million gallons being used. Bleaching powder is also being used to some extent in the disinfection of sewage. Here, also, it has an important field of usefulness.

The rapidity with which the use of this substance has come into popular favor is indicated by the publication of the present work devoted exclusively to the use of chloride of lime in sanitation, and consisting chiefly of abstracts of articles published in various scientific journals. Four hundred of these articles are quoted and the essential points of each briefly stated. The author deserves credit for having brought these various papers together. It would be a tedious matter for any one interested in this topic to obtain so much information by his own search. Looking for omissions the reviewer finds that the compilation has been unusually well made.

The abstracts are prefaced with an interesting discussion of the general subject by the author, who gives first a history of the manufacture of chloride of lime and then an account of the method of its use in water purification and for other purposes of general disinfection. In this he is somewhat inclined to minimize the advantages of the use of liquid chlorine. He regards the action of bleaching powder as one of oxidation and does not believe that chlorine acts by itself as a disinfectant in any other way than by liberating nascent oxygen. Some may be inclined to question this. One of the most valuable sections of the book is that which gives directions for dissolving bleaching powder for its practical application. Comparatively little is said in regard to the corrosion of metals by the use of this chemical.

The book is well indexed and will prove an invaluable reference book to sanitary engineers.

George C. Whipple

The Plant Alkaloids. By Thomas Anderson Henry, Superintendent of Laboratories. Scientific and Technical Department, Imperial Institute. Philadelphia, P. Blakiston's Son & Co. 1913.

So long as there is a science of botany, phytochemistry will constitute a perfectly justifiable phase of chemical thought and of chemical investigation. Though for a time, after Kekulé's enunciation of structural chemistry, phytochemistry was looked upon as being not fully up to date as compared with organic synthesis, it is again coming to its own. Since Emil Fischer has pointed out that some of the most interesting problems of organic chemistry are those that are intimately related to biochemistry, phytochemistry has once more become a respectable science even in the eyes of the synthetic chemist.

The present activity in this field is manifested not only by innumerable special researches, but by the rapid growth of book literature. Thus Czapek's "Biochemie der Pflanzen," Euler's "Grundlagen und Ergebnisse der Pflanzenchemie," and Wehmer's "Pflanzenstoffe," which have appeared within a short

period of six years, are indications of the attempts that are being made to bring together between the two covers of a book the modern knowledge in this field.

Most of the recent books, however, are content to present more detailed accounts of restricted phytochemical groups. Next to the literature on the volatile oils, on the fatty oils, and on the carbohydrates, which have received special consideration, no doubt, because of their industrial significance, the alkaloids have attracted considerable attention.

While the fatty oils and carbohydrates represent decidedly restricted groups of chemical compounds, the volatile oils and alkaloids represent much wider fields, chemically speaking. Biochemically, however, these two groups have been regarded as of much less importance than the carbohydrates and fatty oils. This has, however, not lessened their inherent chemical interest, which has always been appreciated. However, their physiological significance has also grown with our increasing chemical knowledge of the compounds of these two groups. Physiological interest is no longer restricted to skeleton-producing or energy-producing materials. It has broadened and by no means to the disadvantage of the science.

It has been said that modern pharmacology owes its existence to the discovery of the alkaloids. Hence one is not surprised to find the pharmacological aspect of the alkaloids receiving consideration even in a treatise that is predominantly chemical. For the same reason the pharmaceutical aspect of the subject has been given due consideration by the author of the book under consideration. Yet there is a purely phytochemical point of view that deserves more careful study than it has commonly received.

That the author of "The plant alkaloids" should follow conventional lines is possibly to be expected. That he himself does not find satisfaction in so doing becomes only too apparent from various statements that might be quoted from his introduction. From a purely chemical point of view, the alkaloids, like all other carbon compounds, should be classified in accordance with the definition that organic chemistry is the chemistry of the hydrocarbons and their substitution products. Thus the conflicts and the irrationalities of a classification based on the so-called typical groups would be avoided. From a botanical point of view, the alkaloids of a family should be considered together, totally irrespective of the nuclei they are supposed to contain. Thus and thus only can genetic relationships be brought out satisfactorily. Such a treatment not only proves satisfactory in the consideration of a single phytochemical group, but it tends to destroy the arbitrary boundaries of these groups.

Nevertheless, we welcome the author's new treatise. It may be claimed that it would be better to revise one of the older texts on the subject. That such revision becomes necessary very often in these days of great research activity is apparent to all who have occasion to use these texts. However, if a new text brings the subject matter up to date, it, as a rule, not only fulfills this important requirement, it is also apt to do more. It usually introduces new points of view at least here and there. For this reason we often welcome a new text rather than the up-to-date revision of an older one.

E. K.

THE TEMPERATURE ASSIGNED BY LANGLEY TO THE MOON

In his last publication on the lunar temperature,[1] Langley receded from his previous estimate "according to which the soil of an airless planet at the moon's distance

[1] "The Temperature of the Moon. From Researches made at the Allegheny Observatory." *National Academy of Sciences*, Vol. 4, Part 2, Third Memoir, 1889. Two editions of this work were printed. One is said to be "by S. P. Langley," the other "by S. P. Langley and F. W. Very." To prevent misapprehension, I will state that the memoir was the joint work of Mr. Langley and myself. A note written by Mr. Langley, explaining that my name had been omitted from a place on the title page with his own by an oversight noticed too late for correction, was, by some irony of fate, tacked on to the wrong edition, the one which did have my name on the title page.

would have a temperature not greatly above $-225°$ C."[3] On page 197 of that work, a summary of our observations in the lunar spectrum yields the result that "the most reliable spectrum comparisons with a blackened screen show an average 'effective lunar temperature' of $+45°$ C. near the time of full moon." Although the temperature which I had derived from the spectrum comparisons is thus cited, and is the only authoritative figure mentioned, a lingering predilection for his earlier value prevented more than a half-hearted acquiescence in my result on the part of Mr. Langley, who, as chief spokesman, said:[3]

Contrary to all previous expectations, [the extreme infra-red] nevertheless reaches us, thus bringing evidence of the partial transparency of our terrestrial atmosphere even to such rays as are emitted by the soil of our planet. It is probable, as remarked elsewhere, that even of the heat of arctic ice some minute portion escapes by direct radiation into space. If beyond this we can be said to be sure of anything, it is that the actual temperature of the lunar soil is far lower than it is believed to be; but the evidence does not warrant us in fixing its maximum temperature more nearly than to say it is little above 0° Centigrade.

The last part of this extract refers to the belief that the moon's maximum temperature exceeds that of boiling water, a belief which rested on the opinion of Sir John Herschel and on some thermopile measures with a very large probable error which had been made of the total lunar radiation by Lord Rosse, and which, as is well known, had previously been our most reliable source of information.

I may perhaps be permitted to say that the preceding citation from our joint work did not represent the opinion of the junior contributor. Abbot and Fowle, referring to this memoir, speak of my "most recent revision of the evidence";[4] but this is a misapprehension, inasmuch as I have never revised the material contained in the above memoir. My later publications have been founded on new evidence which is entirely distinct.

Mr. Abbot also says in his work on "The Sun" (p. 311):

Upon the moon there is no atmosphere and by the observations of Lord Rosse, of Langley and of Very, the moon's sunlit surface falls from about the temperature of boiling water nearly to that of liquid air within the short duration of a total lunar eclipse.

But the preceding quotations prove that Langley never accepted the doctrine of the "hot moon" while he was director of Allegheny Observatory, and that even when pushed by the evidence, he hung back.

Professor W. H. Pickering in 1902 said:[5]

We do not certainly know the temperature of the moon's surface when exposed to a vertical sun; but according to Professor Langley, it can not be far from 32° F.

N. S. Shaler, in a work published by the Smithsonian Institution in 1903 under Secretary Langley's supervision,[6] said:

The temperature of the moon has been made the matter of numerous experiments. These, for various reasons, have not proved very effective. The most trustworthy, the series undertaken by S. P. Langley, indicate that at no time does the heat attain to that of melting ice.

Consequently, up to 1903, Langley had not accepted the results which I published in 1898.

[3] *Op. cit.*, p. 193. Langley's original statement in regard to the moon's temperature was founded on what he says ("Researches on Solar Heat," p. 213, 1884) concerning the earth's temperature in the absence of a selectively absorbing atmosphere, namely: "The temperature of the earth's surface is not due principally to this direct [solar] radiation, but to the quality of selective absorption in our atmosphere, without which the temperature of the soil in the tropics under a vertical sun would probably not rise above $-200°$ C." This passage contains a mixture of truth and error. The radiation from a tropical surface at 300° Abs. is 285 times that of a similar surface at 73° Abs. The atmosphere has a protective influence, but not one as extraordinary as this. It must be remembered that Stefan's law was not yet fully accepted.

[3] *Op. cit.*, p. 193.

[4] *Annals of the Astrophysical Observatory of the Smithsonian Institution*, Vol. 2, p. 174.

[5] "Is the Moon a Dead Planet?" *The Century Magazine*, May, 1902, p. 91.

[6] "A Comparison of the Features of the Earth and Moon," Smithsonian Contributions to Knowledge, No. 1438. Part of Vol. 34, p. 6.

Although I have not heretofore attempted to revise the memoir on "The Temperature of the Moon," let me say here that the temperature for which I am responsible in that work (namely, $+45°$ C. on the average), and which is given, indeed, but in such a guarded way as to lose much of its force, is certainly too low. In proof of this, reference may be made to figures 11 and 12,[7] which show the position of the lunar image on the very wide slit which was necessary in order to obtain a readable galvanometer deflection in the almost evanescent lunar spectrum. It will be seen that at no time was the slit completely filled by the lunar image. There were always corners occupied by bits of sky, or by the unilluminated part of the moon, while the blackened screen containing boiling water always completely filled the slit aperture. Consequently, the lunar heat was underestimated. Moreover, the lunar radiation was an average pertaining to regions which include a wide range of temperatures, and necessarily fell much below the maximum radiation from the subsolar point.

In the description of the instrumental arrangements[8] we read:

> Care was taken that the lunar image formed by the condensing mirror, and having a diameter of 6.4 mm., should fall accurately upon the central portion of the slit, and thus only that portion is illuminated. In reducing the observations to a standard width of slit, the variation in this width from night to night having been considerable, the assumption is made that the amount of heat passing through the slit varies simply as the width, which is the same as to disregard the curvature of the upper and lower limbs of the lunar image, as well as the secondary effect of the variation of this lunar semi-diameter.

The inaccuracy of this disposition of lunar image and slit is obvious. The only excuse for neglecting it was that the condition of steadiness of our galvanometer at that time was not such as to call for any greater nicety in the other adjustments. No attempt was made to assign a probable error to the numerical results. They were quantitative, but only roughly so. Hence it has seemed to me a waste of time to attempt to revise these measures. It would be better to repeat them with improved facilities.

Whether Secretary Langley ever accepted the results of the later measures which assign a temperature of 454° Abs. Cent.[9] to the lunar subsolar point is not known; but as he had already stepped up from $-225°$ C. to a temperature "a little above zero," let us hope that he may finally have been willing to go the rest of the way.

To those who find it difficult to accept a lunar surface temperature above that of boiling water, because of the low temperature at great elevations in the earth's atmosphere, where the rarefaction is still much less than on the moon, it may be pointed out that the insolation temperature attained by a planetary surface, after allowing for the variation in the intensity of sunshine, depends mainly on two factors: The duration of continuous insolation, and the absorbent power of the planetary atmosphere for return radiation from the planet's surface. The diminution of solar radiation in proportion to the inverse square of the sun's distance determines the available radiant energy, but the temperature acquired through exposure to sunshine depends to a still greater extent upon the nature of the atmospheric trap by which heat is captured. In this respect the greatest variety prevails among the planets of the solar system. The major planets possess denser and more highly absorbent atmospheres, capable of trapping greater and greater amounts of heat, as their distances from the sun increase. The evidences of heat, namely, strong aqueous absorption-bands in the spectrum, prevalence of cloud, and a vigorous circulation in the atmospheres of planets at so great a distance from the sun, may be explained on these principles, as is shown in my paper on "The Greenhouse Theory and Planetary Tempera-

[7] *Op. cit.*, p. 12.

[8] *Op. cit.*, p. 121.

[9] Frank W. Very, "The Probable Range of Temperature on the Moon," II., *Astrophysical Journal*, Vol. 8, p. 284, December, 1898.

tures,"[10] where, however, the application of the theory to Neptune is purely illustrative.

Mars has a rather rare atmosphere, but a climate of the continental type, giving it warm summers. Quantitative measures of the intensification of the aqueous absorption-bands in the spectrum of Mars[11] confirm the evidence of melting polar snows, and assure us that the summer temperature of Mars is considerably above the freezing point.

The earth, since it is nearer to the sun than Mars and has a denser atmosphere, is, on the whole, hotter than Mars. Terrestrial summer climates would be even hotter than they are, if it were not for the tempering effect of its oceans.

The air modifies surface temperatures both by its absorbent and its convective properties. All parts of the earth's insolated surface are cooled by contact with air in motion. This source of thermal depletion is very much smaller on the moon. On the other hand, the earth's temperature is very much increased by the absorbent action of its atmosphere on telluric radiation, an action which is probably very small on the moon, since its visible spectrum shows not the faintest atmospheric absorption. It is well known that the moon's atmosphere is excessively rarefied, yet a minute amount of some especially absorbent vapor might make a considerable difference in the night temperature, if the absorption-bands were of wave-lengths corresponding to low-temperature radiation. Spectrobolometric observations have not favored the supposition, but are hardly delicate enough to reject it absolutely. Without demanding any exact compensation in these two opposite tendencies, it is sufficient to see that they do oppose each other, and that the final controlling factor is duration of insolation. This is great enough on the moon to permit the formation of a steady subsurface thermal gradient, and the attainment of a maximum temperature depending only on the absorptive coefficient of the surface and the solar constant of radiation. The fact to be emphasized is that no estimates of planetary temperatures are possible without considering the nature of the planetary atmospheres and the duration of insolation, and applying a knowledge of the principles of thermal conduction and of the "greenhouse" theory. But the moon is near enough to permit measurements of its radiant emission, in which the only hypothetical element remaining concerns the explanation of the observed facts. Since Abbot and Fowle, in connection with their objections to my value of the lunar temperature,[12] have referred favorably to the opinions of Dr. W. W. Coblentz, it may be well to point out a few statements by the latter writer which demand reconsideration. Dr. Coblentz in his paper, "Radiation from Selectively Reflecting Bodies,"[13] says:

> The reflecting power of the moon for visible rays, according to Langley, is only 1/500,000 full sunlight. Assuming that at 9 μ the reflecting power is, on the average, ten times that at 0.5 to 4 μ (a low [*sic*] estimate), the value becomes 1/50,000.

Here, "reflecting power," or albedo, has been confused with the total amount of light reflected by the moon, expressed as a fraction of sunlight. I found that the average reflecting power of the moon for solar rays of every wave-length, both visible and invisible, was about 13 per cent.[14] Zöllner obtained, for visible rays, a lunar albedo of 17.4 per cent.[15]

[10] *Philosophical Magazine* (6), Vol. 16, p. 478, September, 1908.

[11] Frank W. Very, "Measurements of the Intensification of Aqueous Bands in the Spectrum of Mars," *Lowell Observatory Bulletin*, No. 36; and "New Measures of Martian Absorption Bands on Plate *Bm* 3076," *Ibid.*, No. 49.

[12] *Annals Smithsonian Observatory*, Vol. 2, p. 175.

[13] *Physical Review*, Vol. 24, p. 314, March, 1907.

[14] *Astrophysical Journal*, Vol. 8, p. 275, December, 1898.

[15] This includes a fraction due to specular reflection which causes the phase-curve for moonlight to differ from that for a diffuse reflector, as well as from the phase-curve for proper lunar radiation emitted from the heated surface (for which see Fig. 15 of my "Prize Essay on the Distribution of the Moon's Heat and its Variation with the Phase," and compare with Zöllner's curve in his "Photometrische Untersuchungen"). If the definition of albedo is restricted so as to include only diffuse luminous reflection, we have such values as the following: Wollaston, 0.12; Bond, 0.071;

Ten times these values would be a reflection of more than the whole and "a low estimate"!

To make my meaning entirely clear, let it be noted that the moon occupies on the average about 1/97,300 part of the hemisphere of the sky, and could send to the earth no more than this fraction of sunlight if it had an albedo of unity, or if it were a perfect diffuse reflector. With an albedo of 17.4 per cent., light from the full moon should be $0.174/97,300 = 1/559,300$. This is the fraction for which Coblentz adopts in round numbers 1/500,000. A smooth sphere having the property of specular reflection would yield a small star-like image of the sun of great brilliancy, the rest of the surface remaining dark. Nothing of the sort occurs, and the reflection is mainly diffuse; but the notable increase of brightness at, or near, full moon, and the somewhat greater brightness of the limb, as compared with the center, signifies that there is enough crystalline material in the rocky surface of the moon, and especially upon the cliffs which are presented favorably for observation along the lunar limb, to give an appreciable percentage of scattered specular reflections from innumerable crystalline facets. The distribution of such reflection may differ enough from that for a matte surface to account for the peculiarities of lunar reflection. Infra-red rays, on the whole, are less reflected than visible rays by the moon.

Dr. Coblentz finds for his hypothetical quartz moon an emissive power of 0.1 for a limited section of the spectrum near $9\,\mu$; though his Fig. 5,[16] founded on the observations of Rosenthal, makes this fraction nearer 0.25. We may remark in passing that there are no common minerals with a relative emissivity as low as 0.1, even if we confine attention to this limited region of the spectrum, and that the most notable depression in the lunar spectrum at this point is also shown in the solar spectrum and is probably atmospheric. I speak of a "depression" in the emission-curve, but the depression is only a minor feature in what is otherwise a maximum.

Describing his Fig. 7,[17] Coblentz says:

> In Fig. 7, curves *b*, *c*, *d* show several of Langley's observed lunar radiation curves, and as a whole there is a close parallelism between the theoretical and the observed curve, especially at $10.7\,\mu$, where we have to consider only atmospheric absorption.[18]

There is a mistake here. Curve *d*, Fig. 7, is transferred from curve *c*, Fig. 6, which is derived in turn from the hypothetical emission curve with superposed atmospheric absorption. The supposed "close parallelism" vanishes when this mistake is corrected. The principal feature of the lunar curves is that they show a region of maximum radiation between 8 and $10\,\mu$ (highest point at about $8.3\,\mu$), where the hypothetical emission curve has a minimum. The mistake is indeed corrected a little farther on where we read (p. 318):

> The computed emission curve is the most intense at $10.2\,\mu$, while the observed curve is the most intense at $8.3\,\mu$.

But here another error is introduced, for we are informed that

> this is to be expected if the observed energy curve is the composite of the selectively emitted energy of the moon and the selectively reflected energy of the sun. The selectively reflected energy of the sun would, to a certain extent, fill up the minima in the lunar emission curve, and as far as our present knowledge goes would explain the observed curves *b*, *c*, *d* [*a*?], (Fig. 7), which lack a minimum at $8.5\,\mu$. As a whole, from whatever standpoint we view this matter, we come to the same conclusion, viz.: that in the region from 8 to $10\,\mu$ the energy emitted from the moon consists of its own proper radiation and of reflected energy from the sun.

The explanation, unfortunately for this writer, does not explain, since, as I shall show, the reflected radiation can not possibly exceed about 1/3,000 of the emitted.

At this point in his argument, Dr. Coblentz

Zöllner, 0.1195; W. H. Pickering, 0.0909. Compare Zöllner, "Berechnung der wahren und scheinbaren Albedo des Mondes," *op. cit.*, pp. 161, 162.

[16] *Op. cit.*, p. 317.

[17] *Op. cit.*, p. 319.

[18] *Op. cit.*, p. 318.

introduces the assumption that the absolute temperatures of sun and moon are 5,900° and 350°, and calculates by Planck's formula for the distribution of energy in the spectrum that the ratio of the radiations emitted at these temperatures by complete radiators is 1 : 0.00316.

This ratio of the emissive power [meaning by this the radiation from equal areas] of the moon to that of the sun [considering the latter to be a complete radiator but the former to have a relative emissivity of 0.1] will then be 0.000316, which is 16 times (0.000316 ÷ 0.00002) the reflected energy of the sun from the moon.[19]

But, as we have just seen, the derivation of the fraction 0.00002 is erroneous, the value assumed for the lunar emissivity is improbable even for a narrow region of the spectrum, and still more so for the entire spectrum, and the argument founded on the supposed lunar "reflected energy" is equally inadmissible, as we shall now see.

When it is remembered that the maximum deflection in the lunar spectrum (furnished by a rock-salt prism) at about wave-length 1 μ in the Allegheny measures was usually not over 10 divisions of a millimeter scale, and that the solar radiation at 9 μ is certainly *not more than a hundredth part of that at 1 μ*, or 0.1 mm., the supposition by Coblentz that any appreciable part of the lunar spectrum at 9 μ, coming indiscriminately from all parts of the lunar surface, can be composed of *reflected* solar radiation, is seen to be preposterous.

The question of specular reflection does not enter here. Isothermal charts of the moon[20] show an entirely different distribution of total radiant energy on the moon's apparent disk from that of moonlight, but this distribution of total radiation is not much altered by the small amount of reflected light which it includes, and is altogether appropriate to that of the emission from a heated body having its highest temperature at the subsolar point. Silicates have an emissive power not very different from 0.9 (nine times as great as this author assumes), or a reflecting power seldom much over 0.1. Throughout a considerable part of the region of proper lunar radiation, the reflected solar spectrum must have been smaller than 0.1, perhaps not more than 0.01 scale division, and it would have been absolutely unrecognizable. The actual deflections which reached upwards of 20 or 30 scale divisions in this part of the lunar spectrum were entirely due to emitted radiation; but the part of the lunar spectrum of wave-length shorter than 4 μ corresponded, both in the form of its energy-curve and in the fraction of its included energy, with the reflected solar radiation.

The supposed similarity between the reflection-curves obtained by Coblentz for some common silicates, and the lunar spectral energy-curve, a resemblance which is by no means conspicuous, is purely fortuitous. The lunar curve owes its shape to alteration by absorption in passing through the earth's atmosphere, and not to local abnormal reflection. The resemblance would have been even less approximate if Dr. Coblentz had drawn his theoretical radiation-curve for the temperature which I have indicated for the moon, which is *not* "300° abs.," notwithstanding that the reader of another work by the same writer, "Infra-red Reflection Spectra,"[21] might infer from a footnote that this temperature rests upon my measurements. The curves published in Fig. 90 of the same work and labeled "Reflection from Moon (Langley," can not possibly have the assigned origin, as is evident from the preceding argument. In repeating this figure in the *Physical Review*,[22] the designation has been changed from "reflection" to a noncommital "radiation," but the quotations cited show that the idea of reflection persists.

Dr. Coblentz also infers from observations

[19] *Op. cit.*, p. 315.

[20] Frank W. Very, "Prize Essay on the Distribution of the Moon's Heat and its Variation with the Phase," Utrecht Society of Arts and Sciences, The Hague, 1891. *Cf.* Figs. 7 to 14.

[21] William W. Coblentz, "Investigations of Infra-red Spectra," Part 4, Appendix 1, p. 114. Carnegie Institution of Washington, 1906.

[22] Vol. 24, Fig. 3, p. 312.

measured in the image of the eclipsed moon that the radiation is reflected and not radiated; but the curves which he has drawn[illegible] for the eclipse of September 23, 1885, as measured at Allegheny by Mr. J. E. Keeler and myself, are incorrect, since the heat at no time vanished, although it diminished continually until the end of totality; and in other eclipses which I have observed, the heat measured in the image of the eclipsed moon has never been less than 1 per cent. of its value before eclipse, while the diminution of the light is sometimes a millionfold greater; that is to say, there is simply no comparison between the reflected radiation and that emitted by the heated lunar surface during totality. The radiation enormously exceeds the reflection at that time.[illegible]

I am at a loss to know the source of the statement by Dr. Coblentz that "at the last quarter the heat of the moon is certainly not less than at the full."[illegible] This statement is totally at variance with all published observations.

One other misapprehension needs to be corrected. It is found in the work on "The Moon" by Professor W. H. Pickering.[illegible] Professor Pickering says (p. 20):

The most satisfactory test hitherto made seems to be that of Professor Very (*Astrophysical Journal*, 1898, VIII., p. 266), who compared the amount of heat received from the moon by a bolometer with that received from an equal angular area of sunlit melting snow. The heat was next in each case allowed to pass through a piece of clear glass before reaching the bolometer. The glass allows nearly all the reflected heat to pass, but absorbs that radiated by the body itself. The total radiation in the two cases was about the same, but while the reflected heat was much greater from the snow than from the moon, it was found that the radiated heat was much greater from the moon than from the snow. This means that while the snow is the better reflector, as, indeed, we can see by inspection, the moon is the hotter body. The observation is so direct and simple that it seems impossible to deny the accuracy of the conclusion, but of course it gives us no clue as to what the actual temperature is.

The recognition of the value of this particular observation is all that could be asked, but the really convincing and conclusive experiments with radiating heated minerals, which were performed under identical experimental conditions, and which do give us a "clue as to what the actual temperature is," are not even mentioned in this work, and have been strangely underrated elsewhere.

Professor Pickering goes on to say:

It would be interesting to repeat Professor Very's observation, comparing the radiation from the surface of the moon with that from the surface of rock illuminated by the sun at temperatures ranging from the melting point of snow to the highest attained by rocks on the earth's surface when exposed to a nearly vertical sun.

Experiments somewhat resembling those suggested, but more instructive, had already been performed.

Another instance of the same misapprehension follows. Abbot and Fowle say:

Coblentz has lately shown that some of the materials likely to be prevalent on the moon's surface are very poor radiators at such temperatures as these, and this would tend to explain why Very has found a temperature so much higher than that of a "black body" under similar conditions.

They also remark:

We do not know what its surface is composed of, and therefore have no means of discovering the relations which connect the lunar temperature and radiation.[illegible]

The opinion that "the moon is probably a very bad radiator" is also reiterated by these authors in a recent article,[illegible] where are some personalities to which I need make no further allusion, as they only obscure the real question.

[illegible] *Physical Review*, Vol. 24, Fig. 1, p. 310.

[illegible] Compare Frank W. Very, "The Temperature of the Moon," *Astrophysical Journal*, Vol. 24, p. 354, December, 1906.

[illegible] Carnegie Institution publication, p. 112.

[illegible] Published by John Murray, London, 1904.

[illegible] *Annals Smithsonian Observatory*, Vol. 2, p. 174.

[illegible] *Astrophysical Journal*, Vol. 25, p. 95, March, 1912.

The language of these quotations implies that I have not considered the radiating power of the actual lunar substance, but have assumed an ideal moon; whereas the truth is that extensive observations were made on the radiations from heated silicates and other substances of which the moon's surface is liable to be composed, and comparisons were instituted with these, and not with an ideal radiator, before reaching a final conclusion. The result of this comparison of the radiant behavior of various materials is important, since I find[29] that, given a sufficient duration of insolation to enable a steady state to be reached, there is not much difference in the emission from various materials. Thus a very poor radiator, such as rock salt, radiates from a great depth of its interior substance, and the summation of radiation from many interior layers compensates for the small emission from any one layer. Hence it is not correct in such cases to state emissivity as a surface function. The complete statement of emissivity must be a volumetric one and must include the subsurface thermal gradient.

Ferrel showed on theoretical grounds that the law connecting temperature and radiation for the moon may be expressed as an equation of condition, where, if the coefficients of radiation and absorption of the same substance are always equal, it makes no difference what the substances are; all will eventually reach the same temperature. Some exception to the theory must be made for such substances as ice which are kept cool by melting and evaporation in sunshine. In his actual illustration, Ferrel used the law of Dulong and Petit, but any other formula may be substituted as far as the principle in question is concerned. The important point is that

> the same results would be obtained sensibly with any ordinary conductivity for heat if the same side of the moon were permanently exposed to the sun, for the temperature gradient by which the heat would be conducted inward would soon become so small, in this case, that the rate by which heat would be conducted inward would be insensible, as in the case in which heat is conducted outward from the interior of the earth.[30]

In a different category from the books and articles already cited come such works as that by Fauth.[31] A footnote on page 26 of this book refers to my writings on the moon, but the author does not appear to have read them carefully. On page 139 he says:

> Lord Rosse was enabled by his measurements to appreciate the differences in temperature on the moon's surface during full radiation and by night, and found them to be over 300° C. But the temperature can not be determined with any accuracy. Lord Rosse's results have often been questioned, but they are supported by the recent investigations of Very. Very believes that at the moon's equator, when the sun is at its highest, the ground increases its temperature by more than 100° C. (which would be —173° C.).

This is pretty nearly a hopeless case. I am sure that neither Lord Rosse nor I could recognize our own work in the conclusions attributed to us, where absolute temperatures and temperatures on the centigrade scale are mixed up indiscriminately, in spite of carefully guarded language in the original sources, and where the opinion is hazarded that the *maria* are frozen oceans—a supposition which is completely overthrown by the thermal measures.

The selection of these quotations for special mention does not imply that there are not others equally objectionable in the literature of the subject.

My chief reason for wishing to call attention to the imperfect conceptions of one whose splendid contributions to science condone all minor imperfections is because Langley's early and gradually changing opinions on the subject of lunar temperature still act as a barrier against the acceptance of conclusions which are founded on reliable observations. This will be quite evident from the passages

[29] "The Probable Range of Temperature on the Moon," I., *Astrophysical Journal*, Vol. 8, pp. 199–217, November, 1898.

[30] William Ferrel, Science, Vol. 6, p. 542.

[31] "The Moon in Modern Astronomy," by Ph. Fauth, with an introduction by J. E. Gore, F.R.A.S.

cited from the treatises of Shaler and Pickering.

In conclusion, let me remark that even though we can not go to the moon to see for ourselves what its temperature may be, or whether gravitation acts there as here, or what may be the power of the sun's unabsorbed radiation, we are gifted with reason and can form for ourselves just conclusions from observed facts. Otherwise all astrophysics would be impossible.

FRANK W. VERY

WESTWOOD ASTROPHYSICAL OBSERVATORY,
May, 1912

THE ORE DEPOSITS OF WESTERN UNITED STATES

AMONGST the valuable publications issued by the United States Geological Survey is Mr. James M. Hill's Bulletin 507 with the misleading title "The Mining Districts of the Western United States," as it deals solely with the metalliferous mining districts. These districts are grouped and numbered in each one of the 13 states considered, and their distribution is shown upon 14 maps. The text gives for each district its chief rocks and metalliferous products, the publications of the Survey relating to each one, and the distance and direction of the nearest railroad station, etc. A full index of all the districts mentioned concludes the work, which should be in the hands of every one interested in the ore deposits of the west.

To the general student of metalliferous deposits probably the most instructive portion of the bulletin will be the "Geologic Introduction," by Professor Waldemar Lindgren, late chief geologist of the Survey, present head of the Department of Geology of the Massachusetts Institute of Technology, and one of our foremost mining geologists.

The evidences of the mineral wealth of the Cordillera are found extending territorially from the Pacific shore of United States eastward to western Texas and Oklahoma, and geologically from the Pre-Cambrian to the Recent.

Since the deposition of ores is due to geologic agencies, it is pointed out that in the Cordilleran region, where the rocks are horizontal and undisturbed, the ore deposits are missing or rare and poor. Again, while the metallites occur mostly in the mountain ranges, yet many, even of the highest, are barren; showing that without other conditions, uplift, faulting, and crushing of the rocks, and the circulation of water through them does not always produce ore deposits.

Characteristic important deposits are where Paleozoic sediments have been traversed by moderate-sized eruptive masses of Cretaceous or Tertiary age, the ores apparently being deposited shortly after the intrusion. A less common but often rich deposit is found in Tertiary andesitic and rhyolitic flows.

All these deposits are believed to have been formed by water solutions—largely in fissure veins, chambers, and impregnations. The ores, except gold and its tellurides, were apparently originally deposited as sulphides of lead, iron, zinc, etc., or oxides of iron; but down to or below the permanent water level, which varies from a few hundred to 2,200 feet, these sulphides have been oxidized to cerussite, hematite, calamine, etc. Just below the oxidized zone occur secondary sulphides, like chalcocite and silver-bearing minerals, concentrated by the percolating waters, often into bodies of great richness.

Professor Lindgren gives under each state a more detailed summary, but space does not allow us to continue further, and any one interested can procure a copy by writing to the director of the Geological Survey at Washington.

Without intending to be captious it is suggested that in future editions the term "ores" should be used for "metallic ores" (see pp. 7-9), because there are no ores that are not metalliferous. In the same way "mineral deposits" ought not to be used for metallites or metalliferous deposits when the author intends to exclude the memetallites or non-metalliferous deposits (see pp. 5-9).

M. E. WADSWORTH

UNIVERSITY OF PITTSBURGH

SOCIETIES AND ACADEMIES

NEW YORK ACADEMY OF SCIENCES SECTION OF GEOLOGY AND MINERALOGY

On December 2, 1912, Professor J. Edmund Woodman, chairman of the section, called the meeting to order at 8:25 P.M., in the west hall of the American Museum of Natural History.

No regular business was transacted, but the whole time given over to a lecture on "The Seismograph and What it Teaches," by Professor Harry Fielding Reid. Professor Reid explained the principles of construction and some of the differences in seismographs, using an extensive assortment of lantern views. The lecture was very instructive, and aroused especial interest because of the recent installation by the New York Academy of Sciences of a new seismograph in the American Museum of Natural History, where the section holds its meetings. At the close of the lecture opportunity was given to inspect the new instrument. About 150 members and visitors were present.

Charles P. Berkey,
Secretary of Section

On January 6, 1913, immediately following the adjournment of the regular business meeting of the New York Academy of Sciences, Professor J. Edmund Woodman, chairman of the section, called the meeting to order in the usual meeting place in the American Museum of Natural History, at 8:25 P.M.

Professor D. W. Johnson delivered a paper on "The Shoreline of Cascumpeque Harbor, Prince Edward Island." After explaining with the aid of blackboard maps and sketches the criteria for distinguishing between real and apparent oscillations of shorelines, Professor Johnson further illustrated the discussion with lantern views, amplified where necessary by means of diagrams thrown on the screen. He concluded that the area under discussion is probably the best example of features normally produced by subsidence of a maturely dissected plain to be found on our Atlantic seaboard. He finds no evidence, however, that indicates subsidence in geologically recent times—that is, within the last 2,000 years. In the questionnaire following, the speaker presented still other evidences strengthening his conclusions as to the duration of stable conditions, and made brief references to other localities along the Atlantic coastline of North America.

The program was concluded by brief notices of important papers given at the meeting of the Geological Society of America, at New Haven, Conn., December 28–31, 1912. Ten minutes were devoted to each of the groups, paleontology, economic geology and petrology, by Professor A. W. Graban, Professor James F. Kemp and Charles T. Kirk, respectively. The meeting, though technical, was attended by some fifty persons.

Charles T. Kirk,
Secretary of Section

On February 3, 1913, the chairman of the section, Professor J. Edmund Woodman, called the meeting to order in the west lecture room of the American Museum of Natural History, at 8:30 P.M., and introduced Mr. F. H. Newell, director of the U. S. Reclamation Service. Under the title of "Home-making in the Arid West" the speaker delivered an extremely interesting and instructive lecture on the problems of irrigation in our arid and semi-arid regions. He showed how the United States irrigation engineers must be able to handle a manifold situation. In many instances the determination of flood water possibilities, the areal survey of the project, and the installation of the dam are coupled with such other considerations as soil surveys, building and running a cement plant, constructing and managing a railroad for passenger- as well as freight-traffic, generating and subletting electric power from the flood water spilling over the dams, providing for workmen in isolated settlements—even to furnishing them amusements in the way of motion picture shows—dealing with Indian tribes to the extent of inducing the men to work; all these and other institutions and functions being owned and controlled by the Reclamation Service of the United States government.

To carry out the various projects requires the expenditure of some twelve million dollars annually, or about a million a month. When the score or more of projects are all completed, homes on the farms and in the villages of the arid west will be provided for more than two million families.

The fallacy of dry farming was clearly shown by the loss of about one crop in three through such practise.

The lecture was splendidly illustrated with polychrome slides of very characteristic western views. Owing to unpleasant weather, but 75 persons attended. The audience was further entertained by Director Newell's informal replies to questions from members and visitors after the formal presentation of the subject.

Charles T. Kirk

SCIENCE

FRIDAY, JUNE 27, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE PHYSICO-CHEMICAL CONDITIONS OF ANESTHETIC ACTION[1]

UNDER certain well-defined artificial conditions, as well as under some that are normal, the living system—organism, tissue or cell—becomes temporarily inactive and irresponsive to stimuli. When such an artificially induced state of inhibition is well marked and lasting it is called anesthesia, or in a somewhat more restricted sense, narcosis. This condition may last for hours or even days, but apparently not indefinitely; and when it passes off the normal vital activities and properties return unimpaired. This apparently complete *reversibility* is one of the most remarkable features of anesthesia, and distinguishes it from death—a perhaps related but characteristically irreversible change. The terms "anesthesia" and "narcosis" are somewhat differently applied, although they have the same essential significance; the former relates to any temporarily insensitive condition, however produced, while "narcosis" usually means an anesthesia produced by chemical substances. I shall use the term anesthesia throughout the present address to designate any temporary or reversible lowering or loss of the normal vital responsiveness, or of the normal automatic vital activity, under the influence of certain artificial substances or conditions. Anesthesia, as thus defined, may be exhibited by the most various organisms and cells, if not by all. It is fully as characteristic of plant cells as of animal cells, although its manifestations may be less obvious and striking

[1] Lecture given before the Chemical Society of Washington, April 11, 1913.

in the former group of organisms. In its most familiar aspect the complete organism, *e. g.*, a man, or an isolated living tissue, as a nerve or muscle, fails during anesthesia to show any response to a stimulus which normally excites it strongly. In other words, the capability of responding to stimuli—what we call "irritability"—is in anesthesia diminished or lost. When the condition passes off the normal responsiveness returns unimpaired. Thus a muscle exposed to ether vapor soon ceases to contract on stimulation; under the same conditions a nerve ceases to conduct; in motile plants like sensitive plants the characteristic osmotic motor mechanisms cease to act. Automatic activities like ameboid movement, ciliary movement, protoplasmic flowing, cell division, and growth may also be brought temporarily to a rest by anesthetics. Claude Bernard showed long ago that seedlings ceased growth in an ether-impregnated atmosphere, and resumed it when the ether was removed. Fertilized egg-cells cease to divide in the presence of an anesthetic in appropriate concentration, although they remain living and proceed with cell-division and development when the anesthetic is removed. Other less evident cell-processes, including metabolism, are similarly affected; the rate of oxidation is usually slowed during anesthesia, though there are exceptions to this rule.

It should be remembered that such decrease of the vital activity or responsiveness is not a solely artificial phenomenon. Conditions physiologically resembling anesthesia occur normally in the life of many organisms; sleep is in fact a kind of physiological regularly recurring narcosis due apparently to accumulation of certain metabolic products in the blood or tissues. Again, all irritable tissues lose their responsiveness for a brief period following excitation; this is the so-called "refractory period," which has been compared with narcosis by some physiologists. The resemblance in this case is probably superficial; but I call attention to this phenomenon in order to show once more that temporary loss of irritability may occur under normal or physiological conditions as well as under artificial. There are also noteworthy resemblances between narcosis and fatigue. Thus the degree of irritability of a tissue may vary within a wide range under normal as well as artificial conditions.

We shall first inquire under what general conditions irritable tissues undergo reversible decrease or loss of irritability. These conditions are various. One of them is cold. The living system operates within a narrow range of temperature. Most irritable tissues or cells become less responsive or lose irritability as the temperature approaches zero. In a muscle or nerve of a cold-blooded animal the ability to respond to stimulation is not necessarily decreased by a moderate reduction of temperature—in fact, slight cooling may increase the irritability of nerve; the tissue responds in the typical manner, but the *rate* of the response—as indicated by the duration of the single contraction in muscle or of the electrical variation in nerve—is always decreased, typically to a degree corresponding to the usual temperature-coefficient of chemical reaction-velocity. In the neighborhood of zero stronger stimuli becomes necessary to elicit a response, and eventually none may appear. Different organisms vary in these respects. In some animals, as tropical medusæ, irritability is abolished or greatly lowered at a temperature considerably above zero. The same is true of warm-blooded animals. On return to normal temperature irritability is restored.

Another condition producing effects resembling anesthesia is lack of oxygen. This

retards or arrests activity in many cases; *e. g.*, the nerve cells of vertebrates are very susceptible to lack of oxygen; nerve trunks, on the other hand, are relatively insusceptible. Cell-division—*e. g.*, in developing egg-cells—usually ceases if the oxygen supply is insufficient. Contractile activities are decreased or abolished. Many organisms, however, show only slight immediate effects; this is true of many Protozoa; Vorticellæ, for instance, remain contractile for some time after simple removal of oxygen from the medium, although they are at once paralyzed by anesthetics. Such facts oppose the view held by Verworn and others, that the anesthetic acts primarily on the oxidative mechanism of the cell. It is true that the rate of oxidations in active tissues is lowered during anesthesia, but this effect is rather a consequence than a cause of the lessened activity. Obviously wherever free oxygen is necessary to the normal activities of a tissue its withdrawal will arrest those activities. But the effects produced by lack of oxygen are not to be identified with anesthesia because of such incidental resemblances.

There are also a number of physical conditions that may deprive a cell temporarily of irritability. Thus mechanical shock may have this effect, which, however, is probably to be regarded as essentially a consequence of over-stimulation, causing abnormal prolongation of the refractory period.[2] The same is probably true of the insensibility produced by strong electrical currents. Under certain conditions, however, the electric current may produce effects closely resembling typical anesthesia. This occurs when a weak constant current is passed through an irritable tissue like muscle or nerve; during the flow of the current the irritability of the tissue is modified in the neighborhood of the two electrodes, being heightened at the cathode and lowered at the anode; and in this latter region the nerve may become completely insensitive to stimuli that ordinarily cause strong excitation. The inexcitable state thus produced is called "anelectrotonus"; it is in reality a form of local anesthesia, and as such has been employed for the alleviation of pain in sciatica and similar conditions. Muscle is affected in a similar manner; the frog's heart may thus be rendered locally incapable of contraction, as in the simple class-experiment familiar to all physiologists. This action of the current probably depends on its altering the electrical polarization normal to the membranes of the irritable elements—only in a direction the inverse of that causing stimulation.[3] There is much evidence that the state of polarization of the semipermeable membranes bounding the irritable elements is an important factor in determining the degree of responsiveness to stimulation; the facts of electrotonus indicate that by altering the polarization by an external current the irritability of the tissue may be changed in the direction either of increase or of decrease.

Irritability may, however, be more readily modified by the use of chemical substances than by any other means, and, as is well known, many such substances are in daily use in medical and surgical practise for procuring local or general insensibility to pain—hence the application of the name "anesthetic" to the large class of substances possessing this property. When we inquire into the chemical nature of such substances we find that anesthetic property is confined to no special class, but is ex-

[2] This apparently corresponds to the period of increased permeability and depolarization accompanying stimulation.

[3] *I. e.*, reinforcing instead of diminishing the normal or physiological polarization of the membranes.

hibited by substances of the most diverse chemical character. Acids in low concentration depress the irritability of many tissues; in some cases alkali has this effect; gases like carbon dioxide and nitrous oxide have marked anesthetic action; solutions of magnesium, calcium and strontium salts cause local anesthesia in frog's muscle and nerve; pure solutions of sugar and other indifferent non-electrolytes have similar effects; in these tissues irritability depends on the presence of certain electrolytes, especially sodium salts, in the media and returns on replacing the tissues in solutions containing these salts. But the most significant relationships are seen in the case of the large class of substances, differing widely in chemical constitution and properties, which possess in common the physical property of dissolving fats or of dissolving in fats. These substances include the majority of the anesthetics in common use, as ether, chloroform, ethyl chloride, urethane, etc. The connection between fat-dissolving power and anesthetic property was in fact early recognized—first by Bibra and Harless in 1847; and this relationship is of great physiological significance, since it indicates that the anesthetic is selective in its action on the cell constituents, and produces its effects by changing the state of fatty or fat-like substances in protoplasm. It indicates further that the state of these substances determines the degree of irritability of the cell. All cells, so far as known, contain such substances; they are the so-called "lipoids" which include lecithin and cholesterin, and various other ether-soluble compounds of usually complex constitution. Historically these substances were first grouped into a class simply on account of their fat-like solubilities, so that they form, chemically speaking, a somewhat heterogeneous group, some members of which, as cholesterin, are not fats in any sense. Others, as lecithin, are more closely related to the fats proper. They appear to be invariable constituents of protoplasm—a fact which in itself is not surprising in view of the amino-acid constitution of proteins: since proteins are largely derivatives or condensation-complexes of amino-fatty acids, fat-like substances might be expected to appear in cells during metabolism. It is clear, however, that these substances are not mere by-products of protein metabolism, or reserve material like fats, but play a fundamental rôle in cell-processes; the profound physiological effects produced by all lipoid-solvent substances are a sufficient proof of this, although regarding the precise nature of this rôle we know little as yet. In some intimate way the lipoids appear to be essential to the irritability of the cell, and altering their state causes corresponding changes of irritability.

About fifteen years ago Overton and Hans Meyer investigated the relation between the lipoid-solvent power of a large number of organic anesthetics and the intensity of their narcotic action, and reached independently the conclusion that the chief factor determining this action was the value of the partition-ratio of the anesthetic between water and a typical lipoid like lecithin. That is, for any series of lipoid-soluble compounds the narcotic action increases as the lipoid-solubility increases and the water-solubility decreases. These two solubilities usually show an inverse relation to each other. Now, the view that this form of anesthetic action depends essentially upon a modification of the cell-lipoids—which was put forward simultaneously and independently by Overton and Meyer—is undoubtedly well founded, and is accepted by most physiologists, even although in the absence of any definite and final knowledge of the physiological rôle

of these cell-constituents it is far from being a complete theory of anesthesia. Such a theory would evidently involve a complete theory of stimulation, and this can hardly be said to exist as yet. It is, however, possible, I believe, to gain further insight into the nature of anesthetic action by combining the results of these and similar experimental studies of anesthesia with the results of certain more recent studies of the nature and conditions of the process of normal stimulation. It is necessary to form some clear conception of the nature of the changes involved in stimulation before we can profitably consider the question of just how the stimulation-process is modified by the presence of the anesthetic.

Before considering in more detail the mechanism of stimulation and of its modification by anesthetics, let us first consider briefly the nature of the physico-chemical constitution of the living cell, as more recent research has led us to conceive of it. This is a subject which is not easy to summarize, and on which much light remains to be thrown. It is clear, however, that the living protoplasm is not a homogeneous solution, but is a "polyphasic system"; *i. e.*, a mixture consisting of various substances and solutions which are only partly miscible with one another, and are thus interrelated like the different phases of an emulsion or similar system. These several phases, which are partly solid, partly liquid, appear in each living cell to have a constant and definite arrangement, whose exact nature varies characteristically from cell to cell. There appears typically to be a solid or semi-solid structural substratum consisting of colloidal material, most of which is in a water-swollen or hydrated state; in addition to this more fixed and permanent part of the cell-organization, numerous simpler substances are present—sugars, salts, amino-acids and others—largely in a state of simple aqueous solution, but probably partly adsorbed at the surfaces of the colloidal phases. There is evidence that it is by the oxidation of certain of these substances, especially sugar, rather than of the colloidal material, that most of the energy manifested in the cell-processes is set free. The colloidal substratum furnishes the conditions under which the energy-yielding oxidations and other metabolic changes take place, and apparently determines their course, character and velocity. The solid colloidal material of the cell may in one sense be considered as by-product of the metabolic activities of the protoplasm; it appears, once formed, to undergo itself relatively slight change, but to influence profoundly, by its presence and arrangement, the character of cell-metabolism.[4] The colloids are of varied chemical nature; they are chiefly proteins and lipoids, and it is to be noted that they are built up by various forms of molecular union and polymerization from relatively simple substances furnished by the environment. This is true not only of plants, but also of the individual cells of higher animals, where the material which goes to form proteins reaches the cell in the form of amino-acids, or of simple polypeptides.[5] In general it is from such amino-acids together with salts and carbohydrates that the cell builds up the colloids which form its characteristic structural apparatus. This appears highly complex in some forms of irritable tissue, as in voluntary muscle; in others, as in nerve, the essential structure appears relatively simple. What we call the "structural organization" of the cell is merely another name for the physical char-

[4] *Cf.* Child's interesting discussion of the relation between metabolism and structure in the *Journal of Morphology*, Vol. 22, 1911, p. 173.

[5] *Cf.* Folin's recent papers in the *Journal of Biological Chemistry*.

acteristics and arrangement of the solid colloidal material.

However simply organized a cell may seem, there are certain elements of structure which appear always to be present, and to play a fundamentally important rôle in stimulation and in other life-processes. These are the *membranes*. Most, if not all, living cells are delimited from the medium in which they live by thin semi-permeable colloidal surface-films, the so-called plasma-membranes. Similar semi-permeable partitions are often found in the cell-interior, *e. g.*, about nuclei, vacuoles, chromatophores, and other structures. They appear to be formed of the same colloids as the other protoplasmic structures, namely, proteins and lipoids. These colloids, like many other organic substances, have, when dissolved in water, a marked influence in lowering the surface-tension of the solvent. Any substance thus acting tends, by the operation of Gibbs's principle, to collect or condense on the free surfaces; if the substance is colloidal in nature it may there pass out of solution and form a solid surface-film or membrane; and it is probably under conditions essentially like these that the cell-membranes are formed. Artificial membranes similar in many of their properties to the plasma or nuclear membranes of cells may be formed in protein solutions about droplets of chloroform, mercury or other water-immiscible substances. Now the plasma-membranes of irritable cells undoubtedly play a fundamentally important part in stimulation, as will be seen below, so that it will be necessary to consider first some of the essential properties of these membranes before passing to the consideration of the stimulation-process itself and its modification by anesthetics.

The plasma-membranes are typically *semi-permeable* structures—so much so that living cells form in many cases the most convenient and rapidly acting osmometers that we possess. If we place living cells, like plant-cells or blood corpuscles, in solutions of sugars, neutral salts and various other substances not in themselves immediately injurious to the cells, osmotic effects result from which the osmotic pressure of the solution relatively to that of the cell-contents can be estimated with great accuracy—as the researches of de Vries, Overton, Hedin and many others have shown. Two provisos are necessary in making use of living cells as osmometers: first, the dissolved substance must not by its own action impair the semi-permeability of the membrane, and second, it must not appreciably penetrate the membrane during the time occupied by the experiment. The plasma-membranes are in fact semi-permeable only in relation to certain classes of substances; towards others they show themselves freely permeable, and the character of these substances is important, because indication is thus afforded of the chemical nature of the materials composing the membranes. This is a matter of fundamental importance in the theory of anesthesia. Let us take for example a tissue composed of typical irritable cells, such as a frog's voluntary muscle. In studying the osmotic properties of this tissue, Overton found many years ago that the cells behaved in solutions of certain substances as if they were enclosed by strictly semi-permeable membranes; the chief of such substances are sugars, neutral salts, polyatomic alcohols like mannite, and amino-acids like glycocoll; but toward a large series of mainly organic substances, including alcohols, esters, aldehydes, hydrocarbon-derivatives and others, the membranes behaved as if freely permeable. Thus in an $m/8$ (0.7 per cent.) solution of NaCl the muscle retains its weight unaltered, neither absorbing nor losing water; similarly in solutions

of sugar, mannite or glycocoll of the same osmotic pressure (of about 6 atmospheres). But if to an $m/8$ NaCl solution we add (*e. g.*) alcohol in sufficient quantity to double the *total* osmotic pressure of the solution, it is found that there is no perceptible increase in its osmotic action on the muscle; in other words, the alcohol acts as if it entered the cell with the same readiness as the water. Many other substances show a similar power of freely entering the cell; others like urea, glycol and glycerine also enter, but more slowly. Similar observations in both animal and plant cells have shown that readiness of entrance into cells is a property that is closely correlated with solubility in fats or fat-like substances, including lipoids like lecithin. Substances not so soluble usually gain entrance slowly or imperceptibly. Overton drew from these facts the conclusion that the outer limiting layer or plasma-membrane of living cells consists in large part of lipoids, and that the characteristic osmotic properties of the cell depend on the presence of these substances in the membrane. Since substances that dissolve in lipoids will pass readily through lipoid-impregnated partitions, this view explains why plasma-membranes are in fact readily permeable to such substances as a class. In its detailed application Overton's view has met with considerable opposition; thus, according to Overton, intra-vitam dyes like neutral red and methylene blue enter cells readily *because of* their solubility in lipoids; a certain number of exceptions to this rule have been pointed out by Ruhland and others; but in spite of these discrepancies there seems no doubt—when the whole of the evidence is considered—of the truth of Overton's main contention that lipoid-solubility strongly furthers the ready entrance of substances into cells. Traube believes that the degree of surface-activity, rather than of simple lipoid-solubility, is the determining factor; this property shows a general parallelism with the lipoid-water partition-coefficient, and hence also with the readiness of penetration. But there appear to be more exceptions to Traube's rule than to Overton's, while there are other and independent indications that the surface-films of cells are characteristically rich in lipoids; for instance, the fact that in the eggs of sea-urchins and other animals lipoid-solvents are especially effective in causing the formation of fertilization membranes (a typical surface-effect) and in initiating cell-division; also the facts which I shall cite presently, showing that lipoid-solvents are characteristically effective in altering the permeability of the plasma-membranes and in modifying their resistance to alteration by cytolytic substances.

I dwell upon these researches here because of the light which they throw on the question of the constitution of the plasma-membranes of cells, including those of the irritable tissues. They indicate that the membranes—and perhaps surface-structures in general—are especially rich in lipoids. Now lipoid-soluble substances will tend, by the operation of the partition-law, to concentrate in the lipoids of the tissue; they will thus tend to gather in the membranes, and in so doing they will necessarily modify the physical state of these structures and so influence their physiological properties. We have already seen that the most striking effect which lipoid-solvents produce on irritable tissues is to *modify their irritability*, and under certain conditions to suppress it altogether. This suggests that the membranes have a special relation to stimulation. We should expect on *a priori* grounds that the excitatory apparatus of the cell should be externally situated; and we are thus led to inquire if there is other and independent evidence

that the surface-films or plasma-membranes of the irritable elements play any such special part in stimulation.

There are in fact many indications that this is the case. Investigation of the conditions of electrical excitation—undertaken quite without reference to the problem we are considering—has shown that the semi-permeable membranes of irritable tissues are intimately concerned in stimulation. The first definite proof of this was brought forward in 1899 by Nernst. He was struck with the fact that Tesla currents (or alternating currents of high frequency) may be passed through irritable tissues (or through the human body) without causing stimulation; while if the frequency of the current is sufficiently lowered, but without altering its intensity, strong stimulation results. Now what does this mean? Evidently that the current must flow for a certain minimal time in a *constant direction* in order to stimulate. Mere conduction of a given quantity of electricity through an irritable tissue is not in itself sufficient to cause stimulation. There is some kind of cumulative effect depending on a steady flow in one direction. What physical peculiarities of the living tissue condition this remarkable peculiarity? Nernst pointed out that a living tissue in its relation to the electric current is an electrolytic conductor, which, however, is not homogeneous like an ordinary salt-solution, but peculiar in being sub-divided at intervals by semi-permeable partitions, the cell-membranes. When therefore the current starts to flow it carries as usual anions toward the anode and cations toward the cathode, but at the semi-permeable membranes this movement is blocked; the concentration of anions thus tends to rise above that of cations on the side of the membrane facing the cathode and *vice versa*, and the above behavior of the tissue may be partly explained if we assume that these changes of concentration must reach a certain degree if stimulation is to result. For this effect time is required. Hence, if the current is reversed too soon, the stimulating effect is annulled, and the tissue remains unaffected. Now, if the assumption is true that stimulation is the expression of a change of electrical polarization, due to a change in the concentration of ions at the membranes, the time during which the current must flow in order to produce a given polarization-effect ought to correspond with that needed for a given stimulation-effect. Nernst's analysis shows that the polarizing action varies directly with the intensity of the current (*i. e.*, the quantity of electricity—*i. e*, ions—transported in unit time) and with the square root of its duration ($S = Ki\sqrt{t}$), and observations on a variety of irritable tissues have shown that the stimulating action of a given current does vary in essentially this manner with the duration of its flow in one direction (*i. e.*, inversely with the square root of the number of alternations in the case of an alternating current). It seems clear then that electrical stimulation is dependent on the polarization-changes produced by the current at the semi-permeable membranes of the irritable elements.

One main result of these investigations is thus to localize the stimulating action of the current at the semi-permeable membranes, and to indicate that a change in the electrical polarization of these membranes is an essential feature of stimulation. It is evident that this result does not constitute a complete analysis of the nature of stimulation. But it indicates that some change in the membrane is essential to this process. An electrical variation accompanies every normal stimulation and undoubtedly forms an inseparable feature of the process, but its conditions are still imperfectly under-

stood. There is evidence, however, that it is associated with a definite alteration in the osmotic properties of the membrane. The electrical properties of irritable tissues like muscle indicate that during life there exists permanently in the resting cell a difference of potential, equal roughly to 1/10 volt, between the outer and inner surfaces of the plasma-membrane. When the uninjured outer surface of a muscle or nerve is connected through a galvanometer with the exposed interior of the elements (cut surface) a current, the so-called "demarcation-current," flows from exterior to interior, indicating that the outer surface of the cells or nerve fibers has a higher potential than the interior. This potential-difference appears dependent on the semi-permeability of the plasma-membrane; it is absent in dead cells whose plasma-membranes have lost their semi-permeability, and it is diminished by the application of poisons which impair the normal semi-permeability. Briefly, the demarcation-current potential appears in some way to be inseparably connected with this semi-permeability of the membrane. Ostwald in 1890 suggested a possible explanation of this condition when he pointed out that a membrane might become the seat of a potential difference by interfering unequally with the diffusion of the anions and cations of an electrolyte contained within the cell. If the plasma-membrane allowed cations to pass outward freely, but prevented the passage of anions, a state of things would be produced comparable to what we observe in living cells. But the actual conditions are probably more complex than this, and experimental substantiation of Ostwald's suggestion has not been satisfactory. The subject is evidently one requiring further investigation. In any case, however, the existence of the demarcation-current potential appears dependent on the semi-permeability of the membrane, and whenever the latter undergoes marked increase of permeability, this potential is invariably decreased. The electrical variation or action-current which normally accompanies stimulation may be theoretically accounted for by assuming that at this time the membrane undergoes a decided but temporary increase in permeability, *i. e.*, loses the semi-permeable properties which it possesses during rest, and there is independent evidence that this change actually occurs during stimulation. If this is the case the plasma membrane is the seat of the most constant and characteristic manifestation of stimulation—the electrical variation or action-current. The membrane responds to the stimulating condition by suddenly changing its permeability and hence its electrical polarization.

We are thus brought to the conclusion that the plasma-membrane is characteristically and intimately concerned in the stimulation process. During stimulation it appears to undergo a sudden and quickly reversible increase of permeability. The electrical variation is one expression of this change, but there are others as well. Thus the movements of sensitive plants, which occur under the same conditions of stimulation as those of irritable animal tissues, are due to a collapse of turgid cells, consequent upon a sudden loss of the semi-permeable properties of the plasma-membranes enclosing the osmotically active solution or cell-sap. Here at least is one irritable tissue where the connection between permeability-increase and stimulation seems unmistakable. It might be held that the existence of special osmotic motor mechanisms in certain plants affords no indication of the nature of the conditions in irritable animal cells; but even in animals there are in some cases very clear indications that stimulation is constantly associated with an increase

of permeability, as I shall shortly point out. Evidence from various sides thus proves the participation of the plasma-membranes in the stimulation-process. Just why a change in the permeability and electrical polarization of the plasma-membrane should influence so profoundly the metabolic and other activities of the cell is naturally a far-reaching question requiring further investigation, but there are many reasons for believing that the primary or initiatory phase of the stimulation-process is a change of this nature.

Let us return now to the question of why anesthetics interfere with the stimulation-process. In the first place they can be shown experimentally to interfere with both of the above characteristic manifestations of stimulation, (1) the action-current and (2) the change of permeability. If these are the critical or primary events, on which the other effects following stimulation depend, it is evident that suppression of these must involve a suppression of the entire series of processes resulting from stimulation, including the oxidations, the contraction-changes and the other special features of the response.

That the action-current as well as the mechanical response of a muscle is suppressed by anesthetization has long been known. In nerve also anesthesia abolishes the action-current. Now, on the foregoing hypothesis, the electrical variation is the expression of some alteration in the plasma-membrane, involving a temporary increase of permeability. Höber has found that potassium salts, which deprive nerves of irritability and render them locally negative, cause at the same time a visible alteration in the axis-cylinders; these structures swell and stain more diffusely; he found further that these effects are checked or prevented if the nerves are first anesthetized with ethyl urethane. Experiments on voluntary muscle gave analogous results. If a frog's muscle is partly dipped into an isotonic solution of a potassium or rubidium salt the tissue contracts somewhat and becomes locally negative; this effect is also inhibited or retarded in the presence of an anesthetic.[6] If the local negativity is the expression of a change produced by the salt in the colloids of the plasma-membrane, rendering the latter more permeable than before, Höber's results indicate that the anesthetic decreases the susceptibility to such changes of permeability. If this is the case we can partly understand why the anesthetized tissue becomes less susceptible to stimulation, since stimulation involves an increase of permeability.

Quite recently at Woods Hole I have investigated the question of the nature of anesthetic action in a somewhat different manner, using an organism which seems unusually well adapted to throw clear light on this subject. If an anesthetic acts by so modifying the plasma-membrane of the irritable cell as to render difficult or impossible the rapid variations of permeability which are essential to stimulation, it ought to act similarly on other cells, *i. e.*, it should protect these cells also against the action of permeability-increasing substances or agencies. If an organism can be found whose cells undergo immediate and obvious increase of permeability under conditions which at the same time cause stimulation, it should become possible to determine whether suppressing the stimulating action of a given agency is equivalent to a suppression of its permeability-increasing action. The two effects ought to show a definite parallelism if the above hypothesis is well-based. The organism which I have used is the larva of the marine annelid *Arenicola cristata*. This organism shows

[6] *Cf.* Höber, *Pflüger's Archiv*, 1907, Vol. 120, p. 492.

anatomical features of the required kind. It is a small, worm-like trochophore about 0.3 mm. long, swimming by two ciliated rings and possessing a well-developed musculature of longitudinal fibers. The body cells are permeated with a yellow or brownish pigment, so that when the larvæ are collected in a dense mass (which can readily be done by taking advantage of their strong heliotropism) they appear dark brown in color. Now if such a mass of larvæ is brought suddenly into a pure isotonic NaCl solution, they instantly contract strongly and remain thus contracted for twenty or thirty seconds, after which they slowly relax. During the period of contraction the yellow pigment diffuses rapidly into the solution and colors the latter bright yellow; *i. e.*, strong stimulation of the muscle cells is associated with marked increase in the permeability of the pigment-containing cells. The cilia cease and undergo rapid disintegration at the same time. If now instead of using pure NaCl solution, we bring a similar mass of larvæ into NaCl solution to which a little calcium or magnesium chloride has been added, a strikingly different effect is seen. Stimulation is slight and transitory, there is no immediate loss of pigment, and ciliary action continues uninterrupted. The general toxic action of the NaCl is also greatly lessened. It can thus be shown that pure solutions of sodium salts cause strong stimulating and permeability-increasing effects, both of which are simultaneously prevented by the addition of a little calcium or other antitoxic salt. Prevention of permeability-increase runs parallel with prevention of stimulation. Magnesium salts in pure isotonic solution exhibit an action which is apparently the reverse of that shown by sodium salts. Larvæ brought into $m/3$ $MgCl_2$ show no stimulation, no loss of pigment or destruction of cilia, and little or no immediate injury. On the contrary all muscular movements cease in a few seconds and the larvæ remain permanently motionless during their stay in the solution (except for the cilia which remain active). The effect of the solution is reversible; on return after a few minutes to sea-water, the normal activities at once return. The magnesium salt shows typical anesthetic action, *i. e.*, it renders stimulation difficult or impossible. It also hinders increase of permeability. If larvæ that have lain in $m/3$ $MgCl_2$ for a few minutes are suddenly brought into $m/2$ NaCl, no immediate effect is seen—neither stimulation nor loss of pigment. The toxic action of the pure NaCl is also much less than when the transfer to this solution is made directly from sea-water. In other words, the $MgCl_2$ renders the plasma-membranes resistant to the permeability-increasing or cytolytic action of the NaCl solution; and at the same time it renders the irritable elements resistant to stimulation. The action of the $MgCl_2$ must depend on an alteration of the cell-surfaces, since this salt enters living cells with extreme slowness, if at all. We must conclude that in this instance at least the anesthetic action depends on a modification of the surface-layers or plasma-membranes of the irritable cells or elements.

I have found that lipoid-solvent anesthetics produce effects which are essentially identical with those of $MgCl_2$. The case of ethyl ether, the most widely used of all anesthetics, may serve as an illustration. In a .7 per cent. solution of ether in sea-water *Arenicola* larvæ immediately cease all muscular movements; the cilia show more resistance to anesthesia and remain active. If now the larvæ are transferred to $m/2$ NaCl solution containing the same proportion of ether—so as to preserve the state of anesthesia—no contraction or loss of pigment follows, the cilia continue their activ-

ity, and the injurious action of the pure NaCl is relatively slight. Bringing larvæ from normal sea water directly into ether-containing NaCl solution also causes little or no stimulation or loss of pigment, and the cilia and body cells are protected against the injurious action of the solution. Thus in the presence of the anesthetic the salt solution fails to show its normal stimulating and permeability-increasing action, and its toxic or cytolytic action is greatly diminished. Anti-stimulating and anti-cytolytic actions run parallel with each other.

I have studied the action of a large number of anesthetics in this manner. Those which promptly and completely anesthetize *Arenicola* larvæ in sea-water show, when dissolved in NaCl solution in the proper proportions, effects which are essentially identical with those just described, though varying in degree with the different anesthetics. Alcohols (methyl, ethyl, propyl, butyl, amyl, capryl), the urethanes (methyl, ethyl, phenyl), other esters like ethyl nitrate, acetate, propionate, and compounds like chloretone, acetanilide, paraldehyde, nitromethane, chloroform, acetonitrile, all decrease or prevent the stimulating and permeability-increasing action of pure NaCl solutions when present in the concentrations which cause typical anesthesia in sea-water. They also show well-marked protective or anti-cytolytic action. Other anesthetics, among which are chloral hydrate, benzol, phenyl urea, and chloralose, act more slowly than those just mentioned, and if larvæ are brought suddenly into their solutions in $m/2$ NaCl, stimulation and loss of pigment occur very much as in the pure salt solution. A parallelism between permeability-increasing action and stimulating action is thus seen throughout. If the one effect is decreased or prevented so also is the other.

The exact concentrations most favorable for anesthesia and prevention of permeability-increase are characteristic for each substance and have to be determined empirically. In a series of homologous compounds, like the alcohols or the fatty acid esters, the molecular anesthetic action increases rapidly with increase in molecular weight and in lipoid-water partition-coefficient. The same is true for the vertebrate central nervous system, as Overton and Meyer have shown. Overton's observations on tadpoles show a close parallelism with my own in these respects. The concentrations required to anesthetize *Arenicola* larvæ are, however, higher in every case—usually three to five times higher—than for tadpoles. Possibly the higher salt content of the tissue-media in marine animals is responsible for these differences; the order of relative action is the same in both organisms.

To sum up—it would thus seem that anesthetics produce their essential effects by modifying the properties of the semi-permeable plasma-membranes of the irritable tissues, making these structures more resistant to changes of permeability than normally. Since variations of permeability are essential to stimulation, the irritable tissue is thus rendered temporarily insensitive or irresponsive.

How does the anesthetic produce these effects? Osterhout has recently shown that anesthetics decrease the electrical conductivity of plant tissues, apparently by decreasing the permeability of the plasma-membranes to ions;[7] and it may be that in irritable animal tissues also the permeability normal to the membranes is similarly decreased during anesthesia. If the distinctive action of the anesthetics is to *decrease* permeability, its presence in the tissue will naturally oppose increase of per-

[7] SCIENCE, Vol. 37, 1913, p. 111.

meability and hence interfere with stimulation. The osmotic motor mechanisms of plants, whose action depends on sudden increase of permeability, may in fact readily be rendered irresponsive by anesthetics, as Claude Bernard pointed out long ago in his classical lectures on the life-phenomena common to animals and plants. Or the explanation may be somewhat different. The anesthetic may leave the resting permeability of the membrane the same as before—or perhaps may change it in either direction—but alter its properties so as to decrease the readiness with which the permeability is changed by other agencies acting on the membrane. Changes of condition, electrical or otherwise, that normally act as stimuli would then no longer affect the membrane, and would hence cease to stimulate. But whatever general interpretation we adopt, it is demonstrable that the properties of the membranes are altered during anesthesia in such a way as to make increase of permeability more difficult than in the normal sensitive state of the irritable tissue.

Is this the whole explanation of the anti-stimulating action of anesthetics? Nothing but further experimentation can answer such a question. Suppression of stimulation is however the essential effect to be explained. It must be remembered that any specific response to stimulation comprises a series of mutually interdependent processes, beginning with the one caused directly by the external agent, and ending with the special physiological activity, or response, characteristic of the tissue. It seems more likely that the anesthetic interferes with the *initial* process of such a series than with one occurring later—such as the increase in oxidation or other special effect. The evidence which I have cited indicates in fact that the primary process in stimulation is a *membrane-process,* and that it is this process which is modified by the anesthetic. This is why the succeeding and outwardly more evident effects of stimulation are also modified in the way that we observe.

It is well known that an influential group of physiologists, headed by Verworn, maintain that a suppression or prevention of oxidation-processes is the essential basis of anesthesia. Various facts are adduced in support of this theory. During anesthesia the oxidative metabolism of the tissue is diminished. This fact in itself is equivocal; stimulation causes increased oxidations in many tissues, and suppression of stimulation prevents this effect along with the others. Lack of oxygen arrests many physiological activities that are dependent on its presence, but this fact again does not justify Verworn's identification of narcosis and asphyxia. Other facts seem more consistent with this view. Fröhlich and Heaton find that the recovery of nerves from anesthesia is imperfect or delayed in absence of oxygen; Ishikawa, another pupil of Verworn's, finds the same for Amœbæ; from which they conclude that suppression of oxidations is the essential feature of the condition. These observations merely show once more that the cell or tissue requires oxygen in order to exhibit its normal properties. Mansfeld finds that the concentration of anesthetic required to anesthetize tadpoles is less when oxygen is deficient than when it is abundant; *i. e.,* anesthesia and asphyxia show additive relations to each other. This again is equivocal. The action of nerve-cells is intimately dependent on a good supply of oxygen; when oxygen is deficient their excitability is lowered, and along with this the degree of anesthesia required to abolish excitability. Other parallels of similar nature seem open to objections of the same kind. On the other hand, nerve trunks resist the lack of oxy-

gen or the presence of cyanide (which renders unavailable the oxygen present) remarkably well. Warburg finds that fertilized sea-urchin eggs anesthetized by phenyl urethane, so as to be incapable of cell-division, show nevertheless the same oxygen-consumption as the normal unanesthetized eggs. Again, lack of oxygen interferes only gradually with the ciliary action in many organisms, while anesthetics in sufficient concentration arrest the movement instantly. It seems necessary to conclude from these facts that the essential action of the anesthetic is of a more general kind, and consists in incapacitating some mechanism which is essential to the normal activities of the cell, whether these immediately require oxygen or not.

The evidence which I have reviewed indicates either that this mechanism is the plasma-membrane itself, or that it is closely dependent on the condition of the plasma-membrane. Any condition that renders the membrane incapable of responding to changes of condition by rapid changes of permeability and of electrical polarization has an anesthetic influence. This modification in the properties of the membrane may be produced either by changing the general condition of the colloids forming it—as in the case of magnesium salts or electrolytes in general—or by specifically altering the state of the lipoid-components, as by organic anesthetics. It is impossible to say at present precisely why the solution of an anesthetic in the lipoids of the membrane should thus alter the properties of this structure. The nearest physico-chemical analogy seems to be the so-called "protective action" of colloids, as exemplified in those cases in which the presence of one colloid interferes with or prevents changes of aggregation-state in another, *e. g.*, when gelatine prevents the precipitation of colloidal gold or platinum by a neutral salt like sodium chloride. Apparently the lipoids are related to the other colloids of the membrane in such a manner that the condition of the lipoids affects the entire properties of the colloidal structure, and so determines the effect which an electrolyte like NaCl, or a stimulating condition like an electric shock or mechanical impact, may have upon it. Hence when a lipoid-solvent acts upon the membrane, and dissolves in the lipoids of the latter, it may profoundly change the physical properties of the membrane and hence the responsiveness of the whole tissue or organism to stimulation. On this view the membrane is a main controlling factor in cell-processes, and by changing its state we may alter the entire physiological activity of the cell.

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PSYCHOLOGISTS AS ADMINISTRATORS[1]

Casual statements have frequently been made to the effect that many psychologists leave their professional careers to become administrators of one sort or another, or carry on executive work of a definite kind in addition to their activities as psychologists, with the appended implication that psychology, as a science, suffers a proportionately greater loss of effective workers on this account than do the other sciences. As illustrations of this loss, not a few well-known examples are cited. At first blush, the generalization thus made might be classed under the fallacy of *post hoc, ergo propter hoc*, but in order to escape this charge ourselves, we must submit the matter to some statistical presentation.

The executive positions to which academic men are obviously called are presidencies of colleges and universities, and deanships of departments within colleges and universities. Farther down the scale, viz., directorships of laboratories and headships of divisions and

[1] Read before the meeting of the Experimental Psychologists at Wesleyan University on April 12, 1913.

specific departments, the positions are often only nominal in nature and vary so much from place to place in their attached duties that it does not seem wise to include them in our discussion. The question arises, then, as to which disciplines out of a given group contribute the most men for these executive positions and in what proportions they contribute them. To answer this we selected, from a list of colleges and universities in the United States for the year 1910–11,[3] those institutions which are neither denominational nor technically specialized. This list of 177 institutions was subdivided into those whose enrollment of students was above the 1,000 mark and those whose enrollment was below that mark, with the hope that this crude distinction between the large institution and the small might bring to light a difference in the kind of administrator demanded. The names of the presidents were then looked up in "Who's Who in America" in order to determine their fields of professional interest before they assumed charge of their administrative work. Where interest was considered to be equally divided in several fields, the count was fractionated accordingly. The results are thrown into two classifications: the first may be considered as absolutely determined, the other as relatively determined. Concretely, in the first case, the disciplines are presented in order of rank based upon the per cent. of representation in all the disciplines found; in the second case, a half-dozen sciences are chosen, and the relative rank of representation is given in terms of a per cent. based upon the total representation in these few sciences. The selection of these sciences was made on the basis of a possible comparison of relative worth. Unfortunately there were no available statistics for all disciplines dealt with in the first classification, but in the "Biographical Directory of American Men of Science,"[4] the author found a scale of proportionate values which served as a means of possible interpretation in the second classification. In this directory of over 4,000 names, the relative number of men engaged in about a dozen sciences is given. Some of these sciences are not represented in our lists and are, therefore, not relevant to this discussion. We are forced to limit ourselves, consequently, to the following six sciences to which are attached the corresponding relative per cent. of men engaged in the given activity on the basis of the total number engaged in all of the six activities: biology (27 per cent.), chemistry (22 per cent.), physics (21 per cent.), geology (14 per cent.), mathematics (10 per cent.), and psychology (6 per cent.). The same method of classification was used with a list of 97 deans of colleges and of college departments of universities which were not specialized in profession, *i. e.*, schools of "applied science," "engineering," "medicine," "theology," etc., were not considered because they usually always demanded an executive whose interest lay in the corresponding field of activity. These names were chosen from the 1910–11 catalogues of 42 leading colleges and universities.

CLASSIFICATION 1

111 Presidents of Institutions below 1,000 Student Enrollment	Per Cent.	65 Presidents of Institutions above 1,000 Student Enrollment	Per Cent.	97 Deans	Per Cent.
Theology ..	28	Education ..	20	Mathematics	16
Mathematics	18	Chemistry ..	15	Class. Lit ...	12
English	10	Philosophy .	10	English	12
Education ..	8	Mathematics	9	History	10
Mod. Lang's	7	Polit. Science	9	Polit. Science	10

CLASSIFICATION 2

28 Presidents of Institutions below 1,000 Student Enrollment	Per Cent.	21 Presidents of Institutions above 1,000 Student Enrollment	Per Cent.	33 Deans	Per Cent.
Biology	5		7		11
Chemistry ..	33		11		13
Physics	24		14		23
Geology	5		4		2
Mathematics	28		52		40
Psychology .	5		12		11

[3] This list was furnished by the *World's Almanac* for that year and corroborated by reference to the Report of the Commissioner of Education for the same year.

[4] New York, 1911.

The totals for the second classification are: biology 7.7 per cent., chemistry 19 per cent., physics 20.8 per cent., geology 8.7 per cent., mathematics 40 per cent., and psychology 9.3 per cent.

These tables show, then, that (1) under the absolute classification in the first array, psychology does not appear at all in the rank of the first five disciplines represented, but that (2) under the relative classification of our second array, whereas psychology has the fewest number of representatives engaged in activity in its field, it stands, on the average, fourth on the list of executive representatives, and, if we get its comparative rank in terms of the relative number engaged in the profession, we find that it stands next to the top. This result was obtained by dividing the average per cent., as given in the second table, by the per cent. of number engaged in the profession as outlined above. This value might be termed, for the sake of this discussion, the efficiency-value and results as follows: mathematics 4.00, psychology 1.55, physics .94, chemistry .86, biology .29, and geology .24.

Another investigation was carried on from a slightly different angle. This study was not, like the second classification, a comparative one in terms of other sciences. The question arose as to how many psychologists of repute have been engaged in executive work since they began activity in the field of the science. For this purpose the membership list of the American Psychological Association and Cattell's "American Men of Science" (2d, 1911, edition) were consulted. From the former, a list of about 300 names, 150 names of persons who were recognized in the latter as psychologists were drawn. These names were subdivided into two groups: those recognized as eminent, *i. e.*, among the 1,000 scientists of the country, and, the remainder, those who were not so considered. It was deemed that they had performed executive work if, after they had held some responsible position in psychology, they had become administrators in the sense of the above classifications, or if they had held, or were holding, such positions as superintendencies or principalships of schools, directorships of institutions, or other equivalent positions. It was found that in the first group there were 12 executives out of a possible total of 42 (29 per cent.), and in the second group 36 out of 108 (33 per cent.) came under the rubric of executives. This, the investigator believes, is a fairly large portion of the total, but there is, of course, no ground for believing that psychology is making a better showing in this respect than other sciences, except in so far as the second classification, given above, distinctly indicates it. Undoubtedly, on the score of this classification, the conclusion that psychology, next to mathematics, is contributing more executives relatively than the other sciences mentioned, is valid; and the supposition that the comparison between these sciences, chosen only with reference to available statistics, is fair, must be left to the judgment of the readers of this article.

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THE PLANT INDUSTRY HALL OF THE UNIVERSITY OF NEBRASKA

ON June 10 the University of Nebraska dedicated a new building known as the Plant Industry Hall, to be occupied by the departments of agricultural botany, in charge of Professor Wilcox; horticulture, in charge of Professor Emerson, and entomology, in charge of Professor Bruner. The new building is 140 by 65 feet, and consists of three stories above the basement. It is of strictly fireproof construction throughout.

Short addresses were made by Architect Chowins, Regent Whitmore and Dean Burnett. The principal address on "Practical Science" was given by Professor Dr. John M. Coulter, of the University of Chicago, and will be printed in SCIENCE. These addresses were followed by the ceremony of conferring the honorary degree of doctor of agriculture upon Dean Herbert J. Webber, of the University of California, and Dean Albert F. Woods, of the University of Minnesota.

In conferring these degrees, Chancellor Avery said:

Herbert John Webber, bachelor of science; master of arts; doctor of philosophy; charter member Botanical Seminar, and early assistant in the department; distinguished physiologist, pathologist, and plant breeder; discoverer of motile sperms in *Zamia;* investigator of double fertilization in maize; improver of plants useful for food and clothing; member of learned societies.

Albert Fred Woods, bachelor of science; master of arts; charter member Botanical Seminar, and early assistant in the department; notable investigator; as an administrator distinguished for services in the United States Department of Agriculture; dean of a great college of agriculture; director of a famous experiment station; author and man of affairs.

THE PHYSICAL LABORATORY OF WASHINGTON AND JEFFERSON COLLEGE

THROUGH the generosity of an alumnus, $50,000 was given to Washington and Jefferson College in June, 1911, for the erection of a physics laboratory. An attempt was made to keep within the appropriation, but the cost of erection ran up to $51,090. It is built of cream-colored brick, and measures 60 by 90 feet. The floors are of reinforced concrete, while the walls are solid brick 22 and 18 inches thick. All the laboratories are provided with piers running down to the rock underneath the building or with slate ledges built into the wall. The first floor contains elementary laboratories, workshop, storage room, constant temperature room, and one private laboratory. On the second floor are laboratories for work in electricity and light. Besides there is a chemical laboratory, a supply and stock room, and two private laboratories for advanced work. The third floor is given over to the lecture room, with accompanying preparation and apparatus rooms, a general laboratory for work in mechanics, a dark room, and a laboratory for advanced optics. Electric power is distributed from the dynamo room on the first floor, while the battery distributing center is on the third floor. A reference library and reading room is located on the second floor. The laboratories are all supplied with gas, hot and cold waters, compressed air and exhaust; also, direct, alternating and battery currents are available in each laboratory for power and experimental purposes.

The laboratory was dedicated on January 16, 1913, celebrating the 111th anniversary of the chartering of Jefferson College at Canonsburg. The address was made by Professor A. G. Webster on "Physical Laboratories and their Relation to the Advance of Civilization."

SCIENTIFIC NOTES AND NEWS

HARVARD UNIVERSITY has conferred its doctorate of science on Dr. Chas. D. Walcott, secretary of the Smithsonian Institution.

AMONG honorary degrees conferred by Yale University were doctorates of science on Dr. A. A. Noyes, professor of theoretical chemistry of the Massachusetts Institute of Technology, and on Dr. S. W. Williston, professor of paleontology at the University of Chicago; the doctorate of laws on Dr. John G. Hibben, president of Princeton University, and Dr. David F. Houston, secretary of agriculture, and the master of arts on Dr. Harvey Cushing, professor in the Harvard Medical School.

THE University of Pennsylvania has conferred its doctorate of laws on Dr. G. W. Goethals, chief engineer of the Panama Canal.

BROWN UNIVERSITY has conferred the degree of doctor of science on Mr. Frank M. Chapman, curator of ornithology in the American Museum of Natural History.

WESLEYAN UNIVERSITY has conferred the doctorate of laws on Dr. Charles H. Judd, director of the school of education of the University of Chicago.

TUFTS COLLEGE has conferred the doctorate of science on Admiral Robert E. Peary and the degree of doctor of science on Dr. Alfred C. Lane, Pearson professor of geology and mineralogy in Tufts College.

DURING commencement week at Colorado College there was celebrated the twenty-fifth anniversary of President W. F. Slocum's administration. The following honorary degrees were conferred on scientific men: the degree of doctor of science on Professor T. D. A. Cockerell, of the University of Colorado,

and on Professor William Strieby, of Colorado College, and the degree of doctor of laws on H. A. Howe, of the University of Denver.

Dr. John M. Mecklin has resigned the professorship of mental and moral philosophy at Lafayette College because his teaching was regarded as not in accord with the standards of the Presbyterian church.

The first Loubat prize of $1,000, for the best work printed and published in the English language upon the history, geography, archeology, ethnology, philology or numismatics of North America, during the quinquennial period ending July 1, 1913, has been awarded by Columbia University to George Louis Beer, of New York (A.B., 1892), for his series of works on the British Colonial System. The second prize of $400 has been awarded to Dr. John Reed Swanton, of the Bureau of Ethnology, Washington, D. C., for his two works, one on "The Indian Tribes of the Lower Mississippi Valley," and the other, "Tlingit Myths and Texts."

The Académie Française has awarded the Grand Prix Broquette Gonin, of the value of $2,000, to Professor Grasset, of Montpellier. The prize is for "the author of a work, philosophic, political, or literary, which shall be judged to be of a nature to inspire the love of the true, the beautiful, and the good." Professor Grasset, who is known for his researches on the nervous system, is also the author of several works on questions of psychology, moral responsibility and the philosophy of practical life.

Professor Robert Andrews Millikan, of the department of physics in the University of Chicago, was elected on May 23 president of the local chapter of Sigma Xi. Dr. Henry C. Cowles, of the department of botany, was elected vice-president of the chapter, and Dr. Rollin T. Chamberlin, of the department of geology, secretary.

Dr. Henry A. Bumstead, professor of physics in Yale University, has been given leave of absence for the coming academic year.

Professor Edward Alexander Westermarck, professor of sociology in the University of London, has accepted an invitation to give four lectures next year at Brown University.

Dr. C. S. Sherrington, F.R.S., professor of physiology at Liverpool, has been appointed an additional member of the British departmental committee on the lighting of factories and workshops.

Mr. A. J. Mutchler has been appointed assistant in the department of invertebrate zoology of the American Museum of Natural History.

Mr. A. C. Fraser, of Cornell University, has come to the New York Botanical Garden to assist during the coming summer in the experimental work in plant breeding.

Dr. John Detlefsen, assistant professor of genetics in the University of Illinois, will spend the summer visiting the principal European genetic laboratories.

Nelson C. Brown, M.F., Yale Forest School, in charge of forest utilization in the New York State College of Forestry, is spending the summer studying forest conditions in Germany and Austria.

The Amazon expedition of the University of Pennsylvania, in charge of Dr. W. C. Farabee, arrived in Para, Brazil, last week. Here Dr. Farabee will charter a vessel for the trip in the Amazon regions, according to the original program. The Brazilian government is interested in the expedition, and is aiding the university in various ways.

Dr. Frank Hartley, professor of clinical surgery in Columbia University, has died at the age of fifty-nine years.

The U. S. Civil Service Commission announces an examination for assistant in plant histology, on July 16, to fill a vacancy in this position in the Bureau of Plant Industry, Department of Agriculture, at a salary ranging from $1,200 to $1,620 a year.

The material collected by the third African expedition, under Dr. W. S. Rainsford, has been received at the American Museum of Natural History. It contains specimens of

black rhinoceros, East African buffalo, eland, leopard, cheetah, antelope and monkey.

THE Tokyo Statistical Society of Japan, having recently suffered the loss by fire of a valuable library it had been thirty-three years in gathering, John Hyde, former statistician of the Department of Agriculture, has presented the society with 3,000 volumes of statistical literature to form the nucleus of a new collection. In addition to official publications of 52 countries, printed in twelve different languages, the gift includes the transactions for a long series of years of most of the leading statistical societies of the world, as well as a large number of miscellaneous books of reference. In accepting the gift, the president of the society, Baron Sakatani, former finance minister, announced that the library would be given the name of the donor.

AN ecological conference will be held at the University of Chicago during the summer quarter; the following series of illustrated lectures on "The Relation of Plants and Animals to Environment," will be given beginning July 16, when Professor Henry C. Cowles, of the department of botany, will speak on "Principles and Problems of Ecology as illustrated by Plants." On July 18 Dr. Victor E. Shelford, of the department of zoology, will discuss "Principles and Problems of Ecology as illustrated by Animals." Lecturers in the conference from other institutions will include Arthur C. Tansley, of Cambridge University, who speaks on "British Landscapes"; Professor Carl Schröter, of the University of Zurich, on "The Lake Dwellings and Lake Dwellers of Ancient Switzerland"; Professor Stephen A. Forbes, of the University of Illinois, whose subject is "Fish and their Ecological Relations," and Professor William M. Wheeler, of Harvard University, who will discuss in two lectures "The Habits of Ants."

IT is difficult to realize the enormous quantities of brick used annually in Greater New York. During 1912 the consumption was over 1,000,000 thousand. The principal source of this vast quantity is the Hudson River region, which extends along both sides of the river from New York City to Cohoes and embraces ten counties, nine in New York and one in New Jersey. Other sources of supply are the Raritan River region of New Jersey and the Connecticut region. The year 1912 was one of unusual interest in the Hudson River region. It opened with an increasing demand for brick, and the price for common brick was $7 a thousand, compared with $4.25 in 1911. For several years the use of cement or concrete in construction appeared to be displacing brick to some extent, but owing to the strong "back to brick" movement the year 1912 saw in the New York market a change favoring brick as the best building material for many purposes. Influences that have contributed to this change are the failure of some concrete buildings, the advertising campaign carried on by the brickmakers, and the improved quality of the Hudson River brick. The average price was the highest since 1906. The marketed product in 1912 was larger than that of 1911 and would probably have been still greater but for the scarcity of labor, especially at Haverstraw, and the strike among the brickmakers in the Newburgh district. The strike, however, was of short duration, but the scarcity of labor drawn away by large construction enterprises, such as the Catskill aqueduct, railroad extensions and subway operations, was a serious drawback to the Hudson River brickmakers in 1912. This condition was so serious that the operators resorted to night work and rainy-day work in loading barges and imported laborers from the South. An important development during the year was a large increase in the use of Raritan River brick in New York City, which has for some years been drawing on the Raritan River region. In 1912 the demand for this brick was very much greater than ever before. On the whole the year may be considered one of prosperity. The demand was good, prices were high, the mild weather toward the end of the year permitted shipments to its very close, and while the marketed product was not the largest recorded, it was considerably larger than that of 1911. The statistics gathered by Jefferson Middleton, of the United States Geological

Survey, show that the number of brick marketed in the Hudson River region in 1912 was 1,019,259,000, valued at $5,850,770, or $5.74 a thousand, compared with 926,072,000 brick in 1911, valued at $4,717,633, or $5.09 a thousand. This was an increase in 1912 of 93,187,000 brick and of $1,133,137 in value. The number of operating firms reporting in 1912 was 126. As in other branches of the clay-working industry, the number of active firms reporting is not equivalent to the number of yards, for many firms have more than one yard.

UNIVERSITY AND EDUCATIONAL NEWS

WELLESLEY COLLEGE has received an anonymous gift of $100,000.

IN addition to $250,000 appropriated for a building for the New York State College of Forestry at Syracuse University, the legislature appropriated $50,000 for the maintenance and development of the work for the coming year. Last year through the kindness of Mrs. Russell Sage, who gave something over $80,000, a Division of Agriculture was organized at Syracuse University. This division is giving agricultural instruction for teachers and general work for students of other colleges. These courses in agriculture are given without state or national aid.

GOVERNOR SULZER has signed a bill making the New York American Veterinary College, allied with New York University, the state veterinary college for the eastern part of the state. No appropriation of money was made in the bill.

SOPHIE NEWCOMB COLLEGE, the woman's department of Tulane University, will shortly erect on its new site on Audubon boulevard, adjoining the university proper, four new buildings to cost $600,000.

IT is announced that the executors of the late Sir J. Wernher, Bart., have completed the allocation of the £100,000 bequeathed to them to be devoted to charitable and educational purposes. £35,000 has been allotted to charitable and educational purposes in South Africa, and £65,000 to some 150 different institutions in Great Britain. The grants for scientific and educational purposes include: to the Institute of Mining and Metallurgy, £5,000; the Imperial Service College, Windsor, £2,500; the London School of Tropical Medicine, £1,500.

THE school of medicine of the University of Pittsburgh arranged a medical program in connection with the commencement week exercises. Special clinics were arranged at the hospitals affiliated with the university, as well as laboratory demonstrations at the medical school building on the university campus.

THE Rush Medical College, Chicago, which has for a number of years strongly recommended a fifth clinical year as interne in a hospital, or its equivalent, has made this compulsory for the class entering in 1914. This fifth year is to be spent either in graduate work in one of the departments of the college or as an interne in an approved hospital under the constant supervision of the college faculty.

A GREAT increase in the enrollment has marked the progress of the college of agriculture of the University of Illinois during the past few years. In 1895–96 there was a total enrollment of 14 students; in 1900–01, 159 students; in 1909–10, 660 students and in the present year, 1912–13, there was a total number of 905. The college of agriculture is graduating an ever-increasing number of men. The larger percentage of these graduates are now engaged in practical agriculture. This is shown by statistics being gathered at the present time. Out of ninety-three men graduating this year, forty-four expect to go into actual farming operations; ten expect to enter experimental work at the University of Illinois; ten to teach; eleven will do graduate work; five are going to work for large implement companies, and the rest will be employed in work more or less connected with agriculture.

DR. L. H. BAILEY has resigned the directorship of the New York State College of Agriculture, Cornell University.

DR. PAUL G. WOOLLEY, dean of the medical department of the University of Cincinnati, has resigned this office but retains his professorship.

THE presidency of Tulane, vacant by the resignation of President Craighead a year ago, has been filled by the election of Professor Robert Sharp, dean of the graduate school, acting president during the past year, and for thirty-two years a member of the faculty.

MR. GEORGE WHEELER HINMAN, until recently editor and proprietor of the Chicago *Inter-Ocean*, has been elected president of Marietta College to succeed the late Alfred T. Perry.

MISS JOSEPHINE T. BERRY, of the Washington State College, has been elected professor of nutrition and home economics at the University of Minnesota.

HARRY G. HAKE, of the University of Illinois, has been appointed assistant professor of electrical engineering at Washington University. Joseph C. Stephenson has been appointed instructor in zoology.

AT Vassar College Winifred J. Robinson, Ph.D. (Columbia, 1910), has been advanced from instructor to assistant professor of botany.

MR. W. A. MACDONALD, B.S.F. (Michigan Agricultural College, 1913), has been appointed instructor in forestry in the New York State College of Forestry at Syracuse University.

DISCUSSION AND CORRESPONDENCE

THE LAWS OF NOMENCLATURE IN PALEONTOLOGY

TO THE EDITOR OF SCIENCE: In the course of an interesting and able communication by Dr. Matthew upon "The Laws of Nomenclature in Paleontology" in SCIENCE of May 23, 1913, pp. 788–792, the following paragraph occurs on page 792. The italics here are those of the present writer.

> *Deinodon* Leidy is determinable as to family, but is not determinable generically, as the genera of carnivorous dinosaurs are *now* distinguished. The same is true of a whole series of genera and species described by Leidy and Cope from the Judith River. The treatment of types and referred specimens of these genera by paleontologists as specifically distinguishable or identical has sadly misled Dr. Peale in his recent discussion of the vertebrate evidence as to the age of the Judith River beds, leading him to present as conclusive *evidence of identity in age a correspondence in fauna* which to those who know the nature of the specimens on which the lists are based is no evidence at all.

Inasmuch as the writer hereof is mentioned in this paragraph and this mention may lead to some misapprehension, the following notes are presented. Now as to *Deinodon*, it is submitted that what has been done or is to be done with this genus in the future does not seem to enter the case. Suffice it to say that not only is it mentioned generically by Hatcher and others, but Hatcher in Bulletin 257 of the U. S. Geological Survey (p. 85) gives also a number of species of the genus, and I believe that I am not assuming too much when I take it for granted that others who have referred to these species, or any of them, were referring to the same thing. That the paleontologists may have been at sea in regard to the exact determinations, and that the material is fragmentary and imperfect was as well known to me at the time of writing as to the paleontologist himself, but as the names are a matter of record I think I was justified in using them, no matter what becomes of them in the future, especially as Hatcher, Osborn and others have made important deductions from their occurrence. These remarks apply to the whole series of genera and species referred to by Dr. Matthew. It is rather interesting to have a vertebrate paleontologist make the statement that "correspondence in fauna is not conclusive evidence of identity in age," especially as it rather confirms the statement made by me in my article on the Judith River formation (*Journal of Geology*) wherein, in discussing the evidence of vertebrate fossils on the question of the age of the Judith formation, I say:

> Either the beds are identical in age or vertebrate paleontology has no place in stratigraphic geology and *non geologia sine paleontologia* becomes *non paleontologia sine geologia*.

The writer does not pretend to be a vertebrate paleontologist, nor is he able or willing to pass upon the value of the material studied by them, but he submits that he must be confined to what has been published by them, as

must all who use their material. It is impossible to go back of their record. As they (the vertebrate paleontologists), although fully aware of the fragmentary condition of the material they dealt with, gave not only generic but specific names and made certain deductions from their use, I do not quite understand why I was so sadly misled in using the names as I did, unless, as I said in my paper, vertebrate paleontology is of no use to the stratigraphic geologist. I wish to state here that I thoroughly believe in the value of the evidence of vertebrate paleontology.

While upon this subject, I wish to refer to another point, not, however, mentioned by Dr. Matthew. By some I have been criticized for not including in the lists of vertebrate fossils in my paper all that have been in any way referred to the Judith River formation, from all localities in Montana and in Canada, but it was my idea to limit the list to those found in the typical region of the Judith River formation, and on page 753 of my article on the "Stratigraphic Position and Age of the Judith River Formation" it is distinctly stated that Hatcher's list of Judith River vertebrates is used after the elimination of "all the species which are duplicated under other names" and also of all which come from beds not certainly of Judith age or that occur outside the typical area (the Judith Basin of Montana). A. C. Peale

ICE CAVES

The contribution to *The Popular Science Monthly* for March on "The Sweden Valley Ice Mine," by Marlin O. Andrews, calls for some comment and criticism. In the first place it is calculated to convey the impression that such phenomena as he describes are exceedingly rare, whereas they are fairly common in middle latitudes—especially in limestone districts. In the second place the explanation given of such phenomena is faulty.

The writer of the above mentioned article appears to have come to his subject rather poorly equipped as regards geological knowledge, and though by his own statements supplied by the Federal Survey with information concerning the literature of the subject, to have availed himself very little of it. To begin with, his introduction detailing tradition as to presence in the region of silver mines known only to the Indians, in regard to the reliability of which he appears to have little doubt, does not serve to enhance our confidence in his ability to describe or explain geological phenomena.

Such traditions of "lost silver mines" prevail in nearly every community, but we hardly expect to find a man of science giving credence to them; especially if it is in a region where such mines are a geological impossibility. Potter County, Pa., is in such a region. It may be true that the county has never been covered by a detailed geological survey (a portion of it however has been covered by the Federal Survey and an account given of it in the Gaines Folio), but enough is known geologically of that portion of Pennsylvania to enable us to postulate the presence there of unaltered and little deformed sandstones and shales of Devonian and Carboniferous age, and to assert the entire absence from them of deposits in appreciable amounts of either lead or silver ores. Will the time never come when the diffusion of elemental geological knowledge is such as to render impossible the floating of such absurd "lost-silver-mine-known-only-to-the-Indian traditions"? Where did these Indians acquire their expert mineralogical and metallurgical knowledge that would enable them to detect silver in an ore or extract it therefrom? We know that when discovered by white men the American Indian was living in the "Stone Age" and utterly unacquainted with the extraction of metals from their ores.

When it comes to the account of the ice mine itself, the description in the article must be considered very inadequate from a geological point of view. Was the shaft sunk on undisturbed strata or on talus accumulation? If on the latter, we appear to have here a case of "talus ice accumulation," of which there are many instances. There is at least one other of these in Pennsylvania, if I remember cor-

rectly, either in Center or one of the adjoining counties.

The finding of "petrified wood" and "bones" possibly "human," in sinking the shaft, would seem to indicate talus deposits, but the "fern impressions" point to little shifted carboniferous strata.

Is the wood really "petrified," that is silicified, or does it consist of sandstone casts of same? If the latter, and in strata in place, it indicates carboniferous, and there could be no human bones associated with it. The reference to "loose shale, sharply inclined" up (?) the hill, might indicate overplacement due to creep. The nature of the strata (sandstone and shale) composing the Devonian and Carboniferous of that region would preclude the possibility of extensive underground channels or caverns, which require limestone and would consequently render very problematic the explanation proposed by Mr. Andrews for this Potter ice mine phenomenon.

If a seasonal reversal of underground air currents is to be invoked as an explanation, his diagrams introduced to illustrate this had better be inverted. Every "freezing cave" that has been represented in vertical section shows the more remote recesses of the cave lower than the mouth, and the more nearly vertical the circulation of the air is in consequence of this, the better the conditions for ice accumulation.

This may be illustrated by the conditions which prevail in a "freezing cave" near Gap Creek, Wayne Co., Ky., visited in August, 1898, by the author of this criticism. The cave is in the nature of a vertical sink, the opening of which is situated on the top of a Knob, called "mountain" in that section. The top is about 1,260 feet above sea level (220 above the drainage at the base). Descent into this cave was made by means of rough ladders. Various channels ramify from the main body of the sink, mainly downward. The "mountain" which consists of Mammoth Cave Limestone capped by a thin coping of Kaskaskia Sandstone, appears to be honeycombed with subterranean passages.

Into these passages the cold air tends to descend in winter and from them to rise in summer, due to changes in relative density conditions of the internal and external atmosphere. It appeared also to the writer (and this is the only contribution he wishes to offer to the explanation of ice caves) that the descent of the water through the underground passages during the winter, when this region has its abundant rains, would aid in the intake of cold air at the mouth of the sink somewhat after the manner of a Sprengle pump, and hence would contribute to the thorough refrigeration of the mountain or knob. This agency would operate with little force in summer, when the stage of cave waters is low.

We did not find that the inhabitants in the neighborhood of this Gap Creek ice cave attributed any of the accumulation of ice in it to the summer months, and while it is not impossible in accordance with the theory usually advocated for the explanation of such accumulation, that it might continue after freezing temperatures had disappeared on the outside, there is no indication that this condition of affairs has persisted into the summer, either in the case of this or of any other genuine "glaciere." The result of all actual investigation thus far is in support of this negative. Mr. Andrews fails to offer any first-hand observation in favor of his contention, for by his own statement his visit was made to the "ice mine" in the *spring*. His belief in *summer* accumulation still rests on hearsay evidence.

In view of the fact that such phenomena as we have been here discussing are by no means uncommon (Balch in his work, "Glacieres or Freezing Caverns," cited and quoted from by Mr. Andrews, lists some three hundred instances) it would appear that the subject is important enough to deserve treatment in our text-books on physical geography, where it would appropriately come up under the head of "caverns."

Arthur M. Miller

Kentucky State University,
Lexington

A HUMAN MONSTROSITY

On May 1, 1912, at Fayette, Missouri, was born a female child (colored) having two heads and three arms. The monstrosity was still-born, but had apparently completed its intra-uterine development. It weighed about fourteen pounds.

The legs are two in number, properly placed, and perfectly normal. The trunk as seen from without is fully developed. Posteriorly it is entirely normal, but the breadth increases considerably toward the anterior end. The chest region is at least one half again as broad as it should be. Other than is suggested by the breadth of the chest, however, there are no signs of duplicity in the trunk. The breasts are two in number and far separated, being normally placed with reference to the sides. The spinal column is single and central as far as can be determined without dissection.

Three arms are present. Two show no signs of irregularity either in position or structure. The third is somewhat dwarfed, and is located on a level with the two normal arms and midway between them. It extends upward and backward, and is attached to an irregularly developed scapula resting between the normal ones. The structure of this third arm and its hand is quite abnormal. Both upper and lower arm bones are present, but reduced in size. The wrist bones are not regular or at least do not permit of normal movement. The bones of the hand are not all present, there being only the metacarpals and phalanges of the thumb and first two fingers. The distal segment in each case bears a thickened claw-like nail.

The most striking feature of this monstrosity is its two heads. Each is set at a slight angle with the general axis of the body, and rests close beside, but not crowding, the other. As far as can be observed, there is no abnormality of any sort in connection with these heads except for the position.

There are many problems of scientific interest suggested by this specimen and no doubt many facts of interest and importance will be brought to light upon its dissection.

L. D. Peaslee

Public Museum,
Milwaukee, Wis.

THE OMAHA TRIBE

A review of "The Omaha Tribe," published in Science, June 13, 1913, calls for a few words from the authors, notwithstanding their disinclination to respond to a criticism which in some parts sounds more like vituperation. The opening sentences of the reviewer sound the keynote of his whole effort. He says:

> The most obvious thing about this monograph is the authors' well-nigh complete neglect of the work of their predecessors. It is their avowed purpose (p. 30) to borrow nothing from other observers and to present "only original material gathered directly from the native people." Apart from any consideration of historical justice this principle is unjustifiable from the standpoint of the student.

Now, the paragraph in the preface in the work from which the above is quoted, reads as follows:

> When these studies were begun nothing had been published on the Omaha tribe except short accounts by passing travelers or comments made by government officials. None of these writers had sought to penetrate below the external aspects of Indian life in search of the ideals or belief which animated the acts of the natives. In the account here offered nothing has been borrowed from other observers, only original material gathered directly from the native people has been used and the writer has striven to make, so far as possible, the Omaha his own interpreter.

By comparison of the two quotations it will be readily seen that the context has been willfully disjointed and that a segregated part of it was used as if it were the whole, an unjustified and unscholarly procedure.

The plan and purpose of the authors was to present the results of independent and original investigations on the Omaha, extending for over thirty years, and, as stated on p. 30, to avoid the criticism of other writers. The final adoption of this plan was due in a large degree to the regard which the authors felt for

the late Rev. J. O. Dorsey. They honored his personal character and his conscientious efforts, and preferred silence to the unwelcome task of pointing out the numerous errors throughout his work when he was no longer living to rectify them. Had Mr. Dorsey continued the study of the Omaha language and so perfected his knowledge of it he would have been better able to understand the meaning of the institutions and ideals of the tribe as they were explained to him in the native tongue. Regrettably his imperfect knowledge of the language, as can readily be seen in his Omaha texts, accounts for misconceptions that now appear in his writings.

It is with regret that the authors are now obliged to break the silence which they would have preferred to maintain. The misconceptions of Mr. Dorsey, cited by the reviewer, they corrected in the interest of truth, but without caring to detract from the credit due to the deserving author. Their competency to do so comes from the long and careful study of the tribal institutions and the beliefs on which they were founded, made in conjunction with practically all those men of the tribe who by position and ability were qualified to explain and to interpret tribal life and thought, and also to point out the differences between teachings that were to be taken literally and those which were symbolic in form and character.

The unusual advantages under which the monograph was prepared are indicated in the foreword (p. 30). One of the authors is not only himself an Omaha and well versed in his native language, but is equipped with a knowledge of English, so that niceties of the meaning and of the usage of words are made clear. In consequence of these facts and conditions it was in the power of the authors to state that among the Omaha tribe there was no belief that the ancestors of the people were animals and that at death men returned to the animals from which they sprang.

It would take too much space to reply to all the animadversions and innuendos of the would-be reviewer, nor would any good purpose thereby be served.

FRANCIS LA FLESCHE

SCIENTIFIC BOOKS

Éloges académiques et divers. Volume publié par le comité du jubilé scientifique de M. Gaston Darboux. By GASTON DARBOUX. Paris, A. Hermann & Fils. 1912. Pp. 525 + 4 + portrait. Price, 5 francs.

Jean Gaston Darboux, most eminent of living geometers, was born at Nîmes, France, April 13, 1842. His scientific career may be said to have begun with his entry into the École Normale Supérieure in 1861. To commemorate the fiftieth anniversary of this event[1] it was proposed early in 1911, by a large international group of his mathematical co-workers, friends and former pupils (Professor Hale, of Mount Wilson Observatory, and Professor Hancock, of Cincinnati, were the American representatives), to present to Professor Darboux a gold medal bearing his portrait, and an appropriate address signed by the participants. All mathematicians were invited to share in rendering this honor to Professor Darboux. The response was so generous, the committee was enabled not only to have the eminent artist M. Vernon execute the medal but also to publish a memorial volume. This volume contains a full report of the commemoration proceedings which took place at the Sorbonne, January 21, 1912; Lippmann, Appell, Poincaré, Picard, Volterra, were among the speakers. It also contains 6 éloges historiques (pages 1–306) which Darboux as secrétaire perpetuel delivered before the Academy of Sciences of the Institut after his election in 1900. And finally, we find a dozen of his miscellaneous addresses (pages 307–440) among which mention may be made of that on "The Unity of Science," delivered at St. Louis in 1904, and that on "Fulton and the Academy of Science," delivered in 1909.

The volume is of particular interest to the scientist because of the most attractive style

[1] Curiously enough the letter sent out by the international committee stated that the jubilee of service as a teacher in the system of public instruction in France was to be celebrated. This error is perpetuated on page 443 of the memorial volume to be presently referred to. As a matter of fact, Darboux is even now a year or so short of such a period of service.

of the éloges historiques here collected with annotations from volumes of the *Mémoires de l'Académie des Sciences de l'Institut de France.* Nowhere else are such extended accounts of the scientific careers of Bertrand (pages 1–60), Perrier (pages 61–115), Hermite (pages 116–172), D'Abbadie (pages 173–217), and Meusnier (pages 218–262) to be found.

Joseph Louis François Bertrand (1822–1900) was one of that remarkable group of mathematicians—among them, Poinsot, Poisson, Cauchy, Poncelet, Chasles, Lamé, Le Verrier, Liouville, Halphen, Hermite, Poincaré—who were, at least in part, the product of instruction at the École Polytechnique. A child prodigy and boy not to be bound down by the ordinary routine of the lycée he was nevertheless bachelier, licenciée and docteur ès science when 17 years of age—the youngest doctor of science whom France has ever produced. He then took the entrance examinations for the École Polytechnique. Bertrand has left us some details; Bourdon and Auguste Comte were the examiners:

J'ai le souvenir de l'étonnement de M. Bourdon qui, sachant que j'étais docteur ès sciences, m'avait fait un examen difficile. A la suite de je ne sais quelle réponse, il me dit: "Vous n'avez donc jamais onvert une table de logarithmes?—Je lui répondis: Non, Monsieur, jamais." Il prit cela pour une impertinence; c'était la pure verité. Je n'avais fait aucun, devoir scientifique ou littéraire, jamais aucun calcul demandé par aucun maître.

Bertrand then continues:

A l'École Polytechnique, j'étais un problème pour mes camarades. Reçu le premier et gardaut le premier rang dans toutes les épreuves, je les étonnais de temps en temps par une ignorance scandaleuse sur des notions qu'on enseigne en septième. Beaucoup d'entre eux croyaient à une ignorance affectée; j'en étais très haiteux au contraire. J'ignorais complètement, par example, quelle sorte de mots les grammairiens désignent par le terme d'adverbes.

Bertrand became "répétiteur adjoint d'analyse" at the École Polytechnique in 1844 and professor of analysis in 1856. This position he held till, by reason of the legal age limit, he was retired in 1895, after 51 years of service. On Bertrand, as well as on Poincaré in more recent times, was bestowed the supreme honor which France has in her gift for the élite of her scientists, namely, of election to both the Académie des Sciences (1856) and the Académie Français (1884) of the Institut.

For an account of Bertrand's researches in geometry, analysis, rational mechanics and physics, and of his text-books so popular in secondary education, reference must be made to Darboux's memoir. One may here also find a sketch of his family life and of his personal characteristics.

François Perrier (1833–1888), another graduate of the École Polytechnique, was employed for nearly a score of years by the general army staff, before he became a chief of the geodetic survey and professor of geodesy in the Ecole de Guerre, Paris. His extensive scientific work was in the field of geodesy.

Charles Hermite (1822–1901) at the time of his death was ranked first among French mathematicians. It was in connection with algebra and arithmetic that he was essentially inventor and creator; most notable were his contributions to elliptic and Abelian functions, algebraic forms and the theory of numbers. Through his proof of the transcendence of e he may well share with Lindemann (who employed very similar methods in discussing the transcendence of π) the honor of settling the problem of the squaring of the circle, which had been handed down through the centuries. All these topics and Hermite's career, as professor at the École Polytechnique and at the Sorbonne, as academician, as friend of mathematicians scattered all over the world—are treated at length by Darboux.[1]

Antoine Thompson d'Abbadie (1810–1897)

[1] Disciples of Francis Galton will surely find material of interest in studying hereditary traits of the families of some French mathematicians. For Bertrand was a nephew of Duhamel. Emile Picard and Paul Appell are nephews (the latter by marriage) of Bertrand. Pierre Boutroux is a nephew of Poincaré. Picard's wife was Hermite's daughter and Borel married a daughter of Appell.

was by birth an Irishman. His father, who was descended from an ancient French family, left his native land just before the Revolution and emigrated to Ireland, where he married a Miss Thompson. About 1820 they returned to France with their six children who had been born in Ireland. Two of the children, the brothers, Antoine and Arnaud, became scientists and performed much of their scientific exploration together in Abyssinia and Ethiopia. Antoine was chief of the Venus expedition to Hayti in 1882. Exploration, seismology, geodesy, meteorology, astronomy, claimed his attention at different periods of his life. His principal published work was the monumental "Geodésie de la haute Ethiope" (1873), which appeared shortly after his election to the Academy of Sciences.

General Jean Baptiste Marie Charles Meusnier de Laplace was born at Tours in 1754, and died at Mayence in 1793, as the result of wounds received in battle. Although thus cut off at the early age of 39 "il laissait" to quote the words of one of his friends, "des traces brillantes d'un intelligence d'élite secondée par un zèle infatigable."

His single memoir in pure mathematics was written just as he was leaving the École Polytechnique and contains a complete theory of the curvature of surfaces[3] from an entirely different point of view from that which Euler illuminated in 1763.[4] When Meusnier's memoir was presented to the Institut in 1776 it created a sensation (d'Alembert exclaimed, "Meusnier commence comme je finis"); and although only 22 years of age he was immediately elected a correspondent of the Academy of Sciences. While connected with the army during the next few years, Meusnier constructed a machine for the distillation of sea water and the extraordinary results, in connection with both the theory and practise of aerostation, which he presented to the Academy in 1784, brought about his election as academician.

[3] "Mémoire sur la courbune des Surfaces," *Savants étrangers*, t. X., 1785, pp. 477–510. It is this memoir which contains the famous theorem concerning the curvature of oblique sections of surfaces, with which Meusnier's name is always associated. English writers and the American historian Cajori incorrectly write Meusnier's name without the *s*.

[4] "Recherches sur la courbune des Surfaces," *Mémoires de l'Acad. d. sc. de Berlin*, [t. XVI.] (1760), 1767, pp. 119–143 + 2 Taf. A memoir with this title was presented to the academy by C. G. J. Jacobi on September 8, 1763.

It was in 1783 that Lavoisier and Laplace maintained before the Institut that the "element" water was formed by the combustion of hydrogen in oxygen. But some doubt existed as to the conclusions. This doubt was forever removed a year later, through experiment inspired by the genius of Meusnier. The subject was presented to the Academy in a "Mémoire . . . par MM. Meusnier et Lavoisier."

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Color Standards and Nomenclature. By ROBERT RIDGWAY, M.S., C.M.Z.S., etc.; Curator of the Division of Birds, U. S. National Museum. Pp. iii + 44, with 53 plates containing illustrations of 1,115 named colors, and providing a system of nomenclature permitting the definite location and designation of over 4,000 colors. Published by the author, Washington, D. C. Press work by A. Hoen & Co., Baltimore.

This work is a conspicuous example of that devotion to science which has led a few men to give the better part of their lives to the accomplishment of some important task, their hope of reward being little more than the satisfaction of having finished a work that will serve to advance science, and thus contribute to the welfare of mankind. More than twenty years ago the author began the attempt to supply a practical means of identifying the color of natural objects, so that this important property of these objects might be used with some degree of precision in identifying them. The task has been an enormous one, involving much pioneering in a little understood field of science. Many important problems had to be solved before the work

reached the final stages, and a vast amount of work had to be done over and over again as advances were made. The manner in which the more important of these problems have been met is set forth below.

This book is, of course, not the first attempt that has been made to supply standards of color. Ridgway himself had made an earlier attempt.[1] On this subject the author, in his preface, remarks: "Many works on the subject of color have been published, but most of them are purely technical, and pertain to the physics of color, the painter's needs, or to some particular art or industry alone, or in other ways are unsuited for the use of the zoologist, the botanist, the pathologist or the mineralogist; and the comparatively few works on color intended specially for naturalists have all failed to meet the requirements, either because of an insufficient number of color samples, lack of names or other means of easy identification or designation, or faulty selection and classification of the colors chosen for illustration."

The scheme of classification used is essentially that suggested by Professor J. H. Pillsbury.[2] The key to the arrangement of colors in this scheme is the solar spectrum. augmented by adding to the violet end of the spectrum the hues obtained by mixing violet and red in various proportions by means of the Maxwell color disks.[3]

In determining the number of color standards to be used the first problem was to determine the number of segments into which the original fundamental series should be broken. It is both impracticable and unnecessary to break this continuous series into the more than one thousand hues that are recognizably different to the normal eye. On the other hand, the number of segments must be sufficiently large that the gaps between them may be small enough to serve the practical purpose of identifying colors. On this point the author says: "Distinctions of hue appreciable to the normal eye are so very numerous that the criterion of convenience and practicability must determine the number of segments into which the ideal chromatic scale or circle[4] may be divided in order to best serve the purpose in view. Careful experiment seems to have demonstrated that thirty-six is the practicable limit,[5] and accordingly that number has been adopted."

As far as possible the gaps between each successive pair of these 36 elements of the fundamental series are in each case the same in amount of visual color difference. The scheme of nomenclature adopted provides for an additional color in each of these gaps, so that the fundamental series really consists of 72 named (or rather symbolized) colors, though only 36 are given on the color plates.

The fundamental series of colors thus obtained is modified in three different ways in order to cover the whole range of color variation. Each of these modifications produces a continuous series, which we may call a secondary series. Each of these secondary series begins with the fundamental series, either pure or as modified in a previous secondary

[1] "A Nomenclature of Colors for Naturalists," etc., 1886.

[2] See SCIENCE, June 9, 1893; also *Nature*, Vol. LII., No. 1347, August 22, 1895, pp. 390–402.

[3] If a wheel made up of sectors of different color be rapidly revolved on its axis the various colors will appear to blend into a single color. This is the principle of the Maxwell color disks. Throughout this review when reference is made to the mixing of colors what is meant is the blending of colors produced on a rapidly revolving Maxwell disk having its sectors differently colored. In this sense we may with propriety speak of the blending, say, of black and red as the mixing of these two colors, using the term color in its broadest sense. The mixing of pigments is a different thing, and is not here referred to.

[4] The addition of the hues obtained by various mixtures of violet and red renders the fundamental series a repeating one, and the various hues of which it is composed may hence be arranged in a circle in which there is at all points a gradual change of hue in passing from one primary spectrum color to another. (Footnote by the reviewer.)

[5] "That is to say, the practical limit for pictorial representation of the colors in their various modifications." (Footnote of the author.)

series, and ends with either white, black or neutral gray, according to the character of the modification under consideration. The nature of these secondary series will be understood from the details that follow.

Neutral gray is defined by the author as "being the gray resulting from mixture (on the color wheel) of the three primary colors (red 32, green 42, violet 26 per cent., which in relative darkness equals black 79.5, white 20.5 per cent.)." It may also be described roughly as follows: If by means of a white and a black disk on the color wheel a series of grays be prepared extending from white to black, the visual difference between each of the successive elements of the series being the same, the middle member of this series would be neutral gray. In other words, and roughly speaking, neutral gray is optically half way between white and black.[*]

The first of the three modifications of the fundamental series above mentioned consists of mixing the colors of the fundamental series with neutral gray. This produces a continuous series of "broken," or dull, colors. Since it is manifestly impossible to illustrate on the color plates every infinitesimal element of such a series, it becomes necessary to choose certain points in such series as standards. This choice is based on considerations similar to those involved in breaking up the original fundamental series into segments. Five different admixtures of neutral gray were used, giving five series of broken colors. The elements of the fundamental series are designated in the scheme of nomenclature adopted by the cardinal numerals from 1 to 72, only those designated by the odd numbers being illustrated on the color plates. The first series of broken colors, which are obtained from the fundamental series by the admixture of 32 per cent. of neutral gray, are designated by the primed numbers from 1′ to 71′. The second series of broken colors contain 58 per cent. of neutral gray, and are designated as 1″ to 71″. The third contains 77 per cent. of neutral gray, and are designated by the numbers 1‴ to 69‴. The fourth, 90 per cent., and designated as 1⁗ to 69⁗. The fifth, 95.5 per cent., designated as 1′′′′′ to 67′′′′′.

The fundamental series and the five series of broken colors are represented on the color plates by 150 color specimens. These are arranged in sequence, beginning with red of the fundamental series, and running through the spectrum six times. They form a horizontal line crossing each plate in the middle of the page, and constitute the middle elements of vertical series extending above and below them as follows:

Extending upward from each of these 150 color specimens is a series of "tints" of that particular color. These tints are obtained by mixing each of the 150 colors mentioned with white. Three tints of each color are shown, the first being obtained by mixing with the original colors of the series 9.5 per cent. of white, the second by the admixture of 22.5 and the third of 45 per cent. of white. Above the last tint in each vertical series is a specimen of white.

Extending downward from each of the 150 middle elements described above is a series of "shades" of these elements. The first of these shades is obtained in each case by the admixture of 45 per cent. of black with the original color of the middle series. The second shade contains 70.5 per cent. of black, and the third 87.5 per cent. At the bottom of each vertical column is a specimen of black. For each of the 150 elements obtained from the fundamental series and the five series of broken colors obtained directly from it by the admixture of neutral gray we therefore have a vertical series of shades and tints of that color. Each vertical series extends from white to black, the middle point being one of the 150 middle elements of the scheme of classification. This arrangement of the colors greatly facilitates the comparison of any object with the 1,115 color standards illustrated in the color plates with a view to determining and recording its color.

The system of nomenclature used by the author has already been partially detailed

[*] Some authorities use this term to mean gray of any shade or tint provided it shows no spectrum color.

above. It is the excellent system of identifying each color variation by means of symbols which serve to show the location of the color in the scheme of classification that is the most distinctive and original feature of the work. As stated above, each of the 36 segments of the fundamental series is designated by the odd numbers 1, 3, 5, etc., to 71, the even numbers being reserved for colors intermediate between them. These same numbers modified by the use of primes are used to designate the same colors modified by the admixture of neutral gray. Thus the color designated as 27‴ is number 27 of the fundamental series weakened by the admixture of 77 per cent. of neutral gray (third series of broken colors).

The tints of any color are designated by the number of the color with the addition of one of the letters a, b, c, d, e, f or g. The three tints of each color illustrated on the plates are designated by the letters b, d and f, the other letters being reserved for tints intermediate between those of the specimens in the book. The shades of a color are similarly designated by the number followed by one of the letters h to n. Thus, 35″ i denotes the thirty-fifth segment of the fundamental series diluted as shown in the second series of broken colors, and further reduced by the admixture of 45 per cent. of black.

The system thus provides a means of designating not only each of the 1,115 specimens of color given in the plates, but all kinds of intermediates between them, the total exceeding 4,000 color variations. The magnitude of this task will be appreciated when it is remembered that in the author's previous book the number of colors named and illustrated was only 186, while in Milton Bradley's excellent little treatise on elementary color there are only 126.

The problem of choosing just what hues, tints, shades and broken colors should be represented in the color plates presents many practical difficulties. The simplest phase of this problem is that of choosing the particular spectrum hues to be designated by the simple names red, orange, yellow, green, blue and violet. The authorities are by no means agreed as to just what part of the spectrum is the reddest part of the red, the greenest part of the green, etc. Thus the red of ten different authors varies from 644 to 703 $\times$ 10^{-7} cm. in wave-length. Most of the other colors vary as much according to different authorities. Each author is a law unto himself in such matters. This is one of the reasons why any system of color standards which will serve the main purpose of such standards, namely, that of identifying the actual colors met with in nature and in the arts, would be eagerly adopted by naturalists, as well as by those who find need of color standards in the arts.

A much more important difficulty arises from the fact that certain hues of the fundamental series require more elements than others in the series of tones between white and black in order to make the optical intervals between the tones chosen as standards equal in the different series of tones. The author has chosen to represent three tints and three shades of each of the pure colors. This gives a series of seven elements in each series of tones. Except in the yellows this seems to be very satisfactory, but the eye can distinguish such small differences of tone in this part of the spectrum that a larger number of elements in the series of tones would have been helpful. In the yellows and greens there is also a considerable optical interval between the darkest shade (containing 95.5 per cent. of black) and the adjacent samples of black.

The fact that in the series of broken colors the optical intervals between the adjacent hues are less evident than in the full colors also gives rise to a number of practical difficulties in determining just what elements to drop out in order to make the intervals of suitable magnitude and still cover the range of color variation in a satisfactory manner. None are omitted in the first and second series of broken colors, but in the third and fourth each alternate hue is omitted, while the fifth series contains only the six hues ordinarily designated as the primary spectrum colors, except that yellow-orange replaces orange as